IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No.	:	09/803,173	Confirmation No.: 9334
Applicants	:	Chong Seng Cheng Teng Pin Poo	
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Examiner	:	Choi, Woo H.	
Docket No.	:	1601457-0004	
Customer No.	:	007470	

AFFIDAVIT OF JOHN HYDE UNDER 37 CFR § 1.132

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

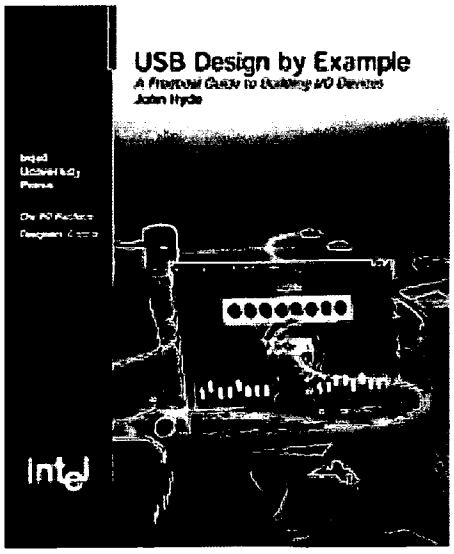
I, John Hyde, of 4545 NW 147th Ave, Portland, OR, 97229, do solemnly and sincerely affirm and say as follows:

1. I obtained a Bachelor of Science degree in Electronics in 1974 from University of Southampton in England. I worked for Intel Corporation for 25 years before leaving in February 2002 to create my own USB Consultancy Business. I am an IEEE Certified Electronics Engineer and have worked in almost every department within Intel. I have held a number of positions during my tenure at Intel, including the Pentium Pro Technical Marketing Manager where I oversaw a staff of 11 people, and Staff Engineer in Intel's Desktop Systems Group where I was responsible for driving industry adoption of a new peripheral expansion bus for the desktop PC now known as the Universal Serial Bus, or USB.

2. I understand and have designed complex-logic, digital, integrated circuits, circuit boards that use these integrated circuits, computer systems that use these circuit boards and systems and applications software that make these systems operate. I am the author of several patents. I am knowledgeable at all levels of a system solution. As a result, Intel often tasked me with resolving many systems integration issues. Intel also decided to "bottle my knowledge" by having me write textbooks.

3. During my tenure at Intel, I had an opportunity to become an expert in USB technology. In 1987, I was responsible for the joint Intel/Microsoft publication "PC98 Hardware Design Guide." Of interest to this case are the sections concerning the expansion of the PC's capabilities, where the direction was basically "Serial and Parallel OUT, USB IN."

4. In 1999, I authored what is considered to be one of the leading treatises in USB device development technology titled "USB Design By Example" (See below).



5. My book has been reviewed as follows: "*USB Design by Example* explains what USB means to hardware developers, taking an approach that combines academic elucidation of the official specification with some experimental setups. . . . John Hyde's explanations represent a valuable supplement to the notably obtuse specification documents. This book does a good job of explaining USB input/output from both the hardware and software perspectives . . . ." Amazon.com.

6. In 2000 I created a major revision of this book called "Second Edition" to cover the advances in USB technology and its applications.

7. More recently I have written a book titled "Multi-role USB Device Design By Example" for Cypress Semiconductor. I currently run a USB Design Consultancy Business and many of the USB products that I have developed for clients are available in stores today.

8. Unless otherwise stated, the matters deposed to herein are within my knowledge or derived from the files and documents to which I have access. Insofar as the matters deposed to herein are within my personal knowledge, they are true and insofar as they are not within my personal knowledge, they are true to the best of my information and belief.

9. I am retained as a consultant to assist in the prosecution of the present patent application by providing a discussion on how the features of the claimed invention resulted in its commercial success based on my expertise and knowledge in the subject matter.

10. I am advised that claim 22 of the present application recites as follows:

A unitary portable data storage device which can be directly plugged into a universal serial bus (USB) socket of a computer and which is operative to function as an alternative to a magnetic disk or CD, and which is capable of storing software for installation to the computer or of receiving and storing user's data present in the computer, the unitary portable data storage device comprising:

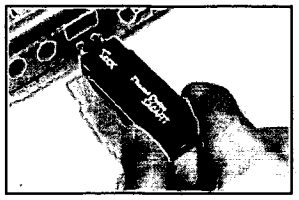
a USB plug integrated into the unitary portable data storage device without an intervening cable capable of coupling the unitary portable data storage device directly to a USB socket on a computer;

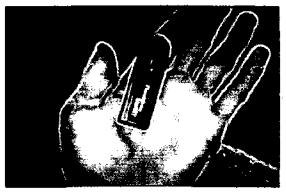
a single interface, said interface allowing the unitary portable data storage device to communicate via the USB protocol and being coupled to the USB plug;

a non-volatile solid-state memory, said memory being non-removable from the unitary portable data storage device and having sufficient capacity to enable the unitary portable data storage device to serve as an alternative to a magnetic disk or CD; and

a memory controller, the memory controller being coupled between the interface and the memory to control the flow of data between the memory and the USB plug in a manner to enable the unitary portable data storage device to operate as an alternative to a magnetic disk or CD.

11. Trek is the company that manufactures and sells the claimed invention recited above under the trademark "ThumbDrive." The claimed invention is a unitary portable data storage device with an integrated universal serial bus (USB) plug that can be directly plugged into a USB socket of a computer without an intervening cable and functions as an alternative to a magnetic disk or CD, capable of storing software for installation to the computer or of receiving and storing user's data present in the computer. It is also of the one-piece, unitary construction in which all parts are integrated and non-removable. It comprises an integrated USB plug, a USB interface, a non-removable memory with sufficient capacity like a magnetic disk or CD, and a memory controller that controls the data flow so that the claimed invention

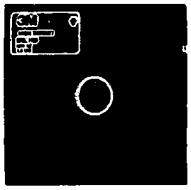




may function like a magnetic disk or CD. The claimed invention (ThumbDrive) was designed to be a replacement to the 3.5 inch floppy disc format and CD ROMs. As will be explained more fully below, it is a self-contained drive and media package that is no bigger than the size of a human thumb. The device plugs directly into the USB port of any computer without any intervening cable and can store and retrieve virtually any digital data from documents, presentations, to music and photos. The popular Windows 2000, ME and XP and Apple's Macintosh operating systems are all supported.

12. Because of all of its features, the claimed invention has been a commercial success ever since it was launched in February 2000, at CeBit 2000, which is the foremost computer and IT fair in the world. I am advised that, since the launch, over 450,000 units of the claimed invention's various versions, e.g., "ThumbDrive Smart," "ThumbDrive Secure," and the latest, the "ThumbDrive Touch," were sold around the world, with sales averaging 12 million Singapore dollars from 2000 to 2003 (approximately 6.8 million U.S. dollars based upon the average exchange rate from 2000 to 2003).

13. To explain why the claimed invention has been commercially successful, I first need to provide some historical background of the claimed invention. Following is a brief examination of what data storage solutions were available in the market before February 2000. The most common form of portable data storage was the ubiquitous floppy disk. This form of storage had been first introduced in the early 1970s and gradually evolved into the 5.25 inch, and later, the current 3.5-inch version (with a maximum capacity of

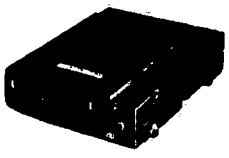


5.25" Floppy Disk

3.5" Floppy Disk

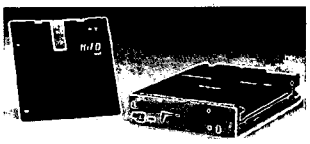
1.44 megabytes). This 3.5-inch version became the universal standard medium for data storage. The long-felt needs for greater capacity storage devices (especially for music and graphic files), however, led to the development and introduction of alternative storage devices. Many touted alternatives, such as IBM's 2.88MB floppy disk, Iomega's ZIP and Jaz Drives, Imation's SuperDisk, Sony's HiFD Drive, and Rewritable Compact Discs, comprise a two-part system, namely a drive (*i.e.*, the mechanism for reading and writing data from and to the storage media) and the storage media itself (usually a magnetic disk or CD). This was the approach utilized by the incumbent "drive and media" systems.

14. Note that all of these devices follow the same implementation model where data is stored on portable media that is inserted into a protective slot that contained the media reader/writer. This protective slot was built into the personal computer itself (*e.g.*, floppy disk slot of a desktop PC or the

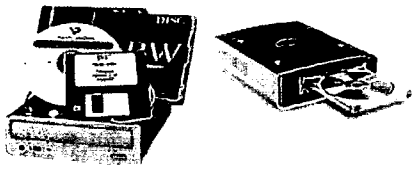


Iomega's Zip Drive

Imation's LS120 Drive



Sony's HiFD Drive



CR-RW Drives

PCMCIA slot of a mobile PC) or it was built into a peripheral device (*e.g.*, an external floppy disk unit or a ZIP drive) that was connected to the personal computer via a cable. The external devices typically had their own power supply due to the current needed for motors to spin the rotating media.

15. For various reasons, none of these touted replacements truly lived up to expectations or replaced the floppy disk as the universal medium for storage.

16. Hence, Trek recognized that there was an unexploited (and potentially huge) market for a new storage device that could replace the floppy disk and still meet or exceed the qualities that made the floppy disk so popular and ubiquitous:

- Universality

The claimed invention is capable of being used on most, if not all, personal computers, regardless of the operating system and without the need for other peripherals. This arises out of the use of an integrated USB plug to connect directly into any open USB socket available on most computers without needing any cable. The use of the USB standard also results in the claimed invention's hot-swappability that brings tremendous convenience in combination of the compact,

integrated design discussed below. The same could not be said for many of the other devices, such as the ZIP Drive or the CD-R/W drive.

- Compactness

The claimed invention is a completely unitary and fully integrated structure with no removable parts. Such construction resulted in its lightweight and small, convenient "form factor" no larger than an adult's thumb. Actually, the compactness had been a significant factor that made the floppy disk popular and has been the key factor that made the claimed invention popular. Furthermore, because of the hot-swappability from the adoption of the USB standard, the compact and integrated "form-factor" offers great convenience in the claimed invention's operations. In contrast, many of the other storage devices were large, heavy, and cumbersome and often needed a separate power source.

- Large Storage Capacity at Lower Cost

Like and even better than a floppy disk, the claimed invention provides large storage capacity without the need for an attendant driver or reader mechanism. As a result, the claimed invention is achieving significant mass-market acceptance. In contrast, the other alternatives, notably CD-R/W and ZIP drives, were and remain comparatively expensive because of the needs of their separate expensive readers.

17. In my opinion, the claimed invention created a paradigm shift in portable computer memory. It created a third method of connecting a storage device to a personal computer: the industry previously had the two methods discussed earlier, *i.e.*, portable media that fit into a protective slot containing a media reader/writer or a cable-connected, independent, peripheral device typically with its own power source. This new third method was an integrated

media+reader/writer device that could be casually appended to a personal computer. There was no need for a specialized, protective slot containing a media reader/writer device since the device integrated its own media reader/writer device and plugged directly into a standard USB socket. The new thinking was in designing a device of unitary construction with all parts integrated and non-removable, specifically one that would require no additional reader/writer and has an integrated Universal Serial Bus ("**USB**") plug directly connectable to the computer without a cable and non-removable memory with large capacity like a magnetic disk or CD. I note that an intervening cable between a USB plug and a USB socket (as an extension cable) was not permitted under the USB Specification at the time of the claimed invention. Hence, one skilled in the art would understand that the USB plug of the claimed invention would be capable of being directly plugged into a USB socket on a PC without any intervening cable.

18. The integration of the all the reader/writer and storage parts into one unitary and compact package resulted in a device that was more convenient and portable than the other mass storage devices. The user no longer had to carry separate cables, adaptors, or memory medias (such as magnetic disks or CDs) to use the claimed invention. They were also assured that they could access the data on the device on almost all computers.

19. The need for the unitary integration drove Trek to employ flash memory as the storage media. Flash memory chips not only enabled a small form factor to be achieved but also resulted in a more robust storage media than say, magnetic disks or CDs. No separate reader/writer also meant that no need for substantial current to be drawn through the USB port. The claimed invention works with the 500 mA (milliamperes) and 5 volts offered by the USB port. At the time, the current offered by a USB port would generally

have been insufficient for some other storage devices such as rotating media due to the drive motors.

20. Also, to achieve the total unitary integration, the memory controller for the device would have to be built into the claimed invention. A memory controller controls the flow of data between the host computer and the claimed invention. Trek would need a memory controller having the capability to control the flow of data so that the claimed invention could operate like a magnetic disk or CD.

21. Serial interface flash components, such as those found in Smart Cards or those used for saving configuration data, would be too slow and too small to be used in the claimed invention (at the material time the upper storage limit for these components was 1 KiloByte). A Smart Card has a serial interface and is thus an inherently slow device when compared with other data storage devices. In addition, since the amount of data stored on a Smart Card is so small, there is no requirement to move this data into and out of the device at high performance.

22. Trek also needed a USB controller because of the adoption of the USB standard for the claimed invention. At the material time USB supported two speeds: low at 1.5Mb/s and full at 12Mb/s. The performance requirement discussed in the previous section would dictate the use of a full speed USB controller instead of a low speed one. As a result, Trek chose to use a Philips D12 (PDIUSBD12) component (operating at the full-speed 12Mb/s) as the USB interface controller in the claimed invention rather than the then popular low-speed Cypress Semiconductor CY7C63001A component. A person skilled in electronics or electrical art at the material time would understand that the Philips D12 component was designed to be used on a printed circuit board (PCB) in close proximity to a USB connector.

Launch of Claimed Invention (ThumbDrive)

23. I am advised that, after months of discussions and research work, the claimed invention was finally launched at CeBit 2000 in Hanover, Germany in March 2000, under the name "**ThumbDrive**" and subsequently at COMDEX SPRING 2000 in Chicago, PC EXPO in New York, and COMPUTEX fair in Taiwan. There was no other company that exhibited any device that resembled the claimed invention (ThumbDrive).

24. The claimed invention became a success because of the claimed invention's universality, compactness, and low-cost storage capacity discussed above. There was, simply put, nothing like it in the storage market. Some industry comments, which demonstrate that the claimed invention succeeded in achieving what it had set out to accomplish, *i.e.*, to fulfill the long-felt needs for a greater capacity storage device that is universal, compact, and with high capacity as discussed earlier, are reproduced below:

- *"The most impressive bit of hardware technology at COMDEX was also the smallest. It's called the ThumbDrive, from Trek 2000 International Ltd. (www.thumbdrive.com). The idea for this device is so clever and handy that I'm surprised that nobody else has thought of it before...Once you've stuck the ThumbDrive into a USB port, what have you got? You've got an ultra high speed 'disk drive' holding from 8MB to 256MB of data..., in a finger sized device that is practically indestructible."* [from The Chicago Computer Guide]

- *"If you want handy, portable storage, you might want to try out Trek's ThumbDrive."* [from Computer Times, 22 March 2000]

- *"[T]he Trek ThumbDrive is actually an attractive alternative to all those monosyllabic, mobile megabyte machines: Zip, Jaz, Clik! and Orb."* [from www.reviewsonline.com, 20 April 2000]

- *"The ThumbDrive is certainly a pretty innovative and nifty product."* [from www.hardwarezone.com]

- *"In the search for a new way to store data, Trek 2000 International has created the Trek Thumbdrive...the best part of the Thumbdrive is that 'no software, no connection wire and no battery are required.'"* [from www.edgereview.com, 29 June 2000]

- *"Meanwhile, Trek, a virtually unknown company from Singapore, has created an amazing little 'hard drive' that plugs directly into any USB port...Also unlike Smart Media, Compact Flash, and other forms of solid-state removable media that requires some sort of adapter, the ThumbDrive requires only an open USB port. This universality will take this drive a long way. That the drive is bus powered (powered by computer) makes this an even more intriguing product...it reminds us of a gadget out of a spy thriller."* [from www.techtv.com, 14 July 2000]

- *"The ThumbDrive takes an innovative approach to using the USB port by plugging directly into it. No connection cable is necessary."* [from www.mistupid.com]

- "*The ThumbDrive is billed as the world's smallest storage device, and this tiny unit will give you quick and easy access to your data when you're on the move . . . No additional adapters, power, batteries, cables or card readers are required.*" [from PC Magazine, Feb 2001 issue]

- "*In this new age of technology products are getting smaller, smarter and more convenient for end users. Technology has become part of our everyday lifestyle. Such things as cell phones, PDA's, and laptops are all designed with ease of portability in mind. They are made light, small and designed to go wherever you go. There is a new trend in town and that is being able to carry amounts of data around with you to be able to access elsewhere. The leading product in this trend is the Thumbdrive. Trek USA is one of the leading companies to offer products of this new trend. Their Thumbdrive products offer great portability with its thumb size design and ease of use. With its USB interface data can be transferred quickly and simply without having to load any drivers (except for Windows 98 and 98SE) which makes this product stand above the competition.*" [from www.techwarelabs.com, 12 June 2002]

Copies of these reviews have been exhibited at "**JH-1**," which also includes a list of the awards garnered by the claimed invention (ThumbDrive) as well as stories of companies that have adopted the claimed invention into their essential business operations.

Commercial Success

25. I am advised that, soon after the launch, Trek started on promoting and marketing the claimed invention around the world. Apart from the CeBit and COMDEX shows in 2000, Trek also exhibited the claimed invention at the Computex show in Taiwan. I am advised that the average sales of claimed invention (ThumbDrive) were in excess of 12 million Singapore dollars from 2000 to 2003 (approximately 6.8 million U.S. dollars based upon the average exchange rate from 2000 to 2003).

26. I am advised that, in October 2001, Trek was selected by IBM to manufacture what are essentially the "ThumbDrive" products for IBM, to be sold as "IBM Memory Key." A similar deal was entered into with Sonnet Technologies in December 2001.

27. Since the launch, the claimed invention has become close to being regarded by the industry as the true replacement for the floppy drive. This is not surprising as the claimed invention offered all of the advantages of the floppy disk (universality, compactness, affordable storage capacity, *etc.*) but with the advantage of having significantly larger storage capacities than the floppy disk, promise of even greater storage capacities in the future, but at a miniscule fraction of the size. For example, a single 128MB version has the equivalent capacity of about 88 pieces of 3.5-inch floppy disks.

28. That the claimed invention (ThumbDrive) was the first in the world and the only complete solution to the search for the replacement for the floppy disk is clear.

- "*The ThumbDrive is a technological breakthrough...*" [from www.storagesearch. com, February 2000]

- One article (www.techwarelabs.com) described Trek as "*...a pioneer in mobile storage solution.... In Feb 2000, Trek introduced the Thumbdrive, a portable USB-powered solid-state storage solution that brought about the beginning of the end of floppy drives.*"

- A local review (IT AsiaOne, 28 June 2000) called it a "*groundbreaking product.*"

- Another article (www.tcbizreview.com, May 2002) described the ThumbDrive as "*The one that started it all.*"

29. It was so revolutionary that one review (ZDNet India, 2 February 2001) had this to say:

> "*Imagine a device that uses no batteries, no software, no cables, and no external hardware required to transfer and store data. Imagine a drive that is so small that you can carry in your pocket. Welcome aboard the 16MB Trek ThumbDrive...*"

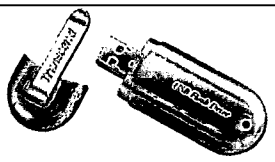
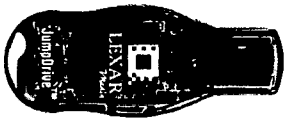
The aforementioned four articles are exhibited hereto, marked "**JH-2**."

30. Recently, some PC manufacturers began to sell PCs without a floppy disk drive. In February 2003, Dell Corporation, the largest PC manufacturer in the world, announced that it would treat floppy drives as an optional item. Another article, from ww.bbc.com, heralded the growing popularity of what the author called "keyring drives." This further enforces the claimed invention's being a replacement for floppy disk.

I now produce and exhibit hereto, the aforesaid articles, marked "**JH-3**."

Copying by Others

31. After Trek introduced its claimed invention (ThumbDrive) into the market, companies around the globe have copied the claimed invention and began selling their own clones. A non-exhaustive list of such companies and their products (which are ever increasing) is as follows:

Name of company	**Product Name**	**Pictorial representation**
EZ Drive	EZ Drive	
Transcend	Pen FlashDrive	
Edge Memory	DiskGo!	
Lexar Media	JumpDrive	
TwinMos Technologies	Mobile Disk	

Name of company	Product Name	Pictorial representation
Viking Components	USB Drive	
Ritronics Components	SlimDisk Diskey	 

32. Trek was granted a patent in respect of the claimed invention, namely, Singapore Patent No 87504 [WO 01/61692] ("the ThumbDrive Patent") on 16 April 2002 by the Intellectual Property Office of Singapore.

A copy of the ThumbDrive Patent is now produced and exhibited hereto, marked "**JH-4**."

33. I am advised that the patent has been litigated and upheld in Singapore.

A copy of the Singapore judgment is now produced and exhibited hereto, marked "**JH-5**."

34. I am advised that the patent offices of the United Kingdom, Australia, New Zealand and South Africa, amongst others, have decided to grant patents in respect of the claimed invention, whilst other patent applications are pending in China, Japan and Europe. Trek has filed applications for a patent for the claimed invention in a total of 34 countries around the world.

Copies of patent certificates or letters confirming the grant of patents in some of these countries are now produced and collectively exhibited hereto, marked "**JH-6**."

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true and further that these statements are made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment or both under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the present application or any patent issued thereon.

Respectfully submitted,

Dated: November 28, 2005

John Hyde

John Hyde

TREK ThumbDrive®

AWARDS & REVIEWS

AWARDS ■

PRESS REVIEWS

CONSUMER SOLUTIONS

July 2000	ZDTV (now TechTV), US Awarded	★★★★☆
Sep 2000	Best New Technology, Australia	
Oct 2000	Computer User Creativity Award, Thailand	
Nov 2000	PCWorld Award, Norway	
Nov 2000	Excellence Award, UK	
Dec 2000	Hardwarezone.com, Singapore	
Jan 2001	PC Expert Excellence Technique, France	
May 2001	MIStupid.com, US Awarded	★★★★☆
Jan 2002	PC World, US Awarded	★★★½☆
Jan 2003	2003 Consumer Electronics Show (CES) Design & Engineering Showcase Honors	

La rédaction de PC Expert *va décerner les Prix d'Excellence Technique*

À cette occasion, nous avons le plaisir de vous annoncer que

Votre produit ThumbDrive

est nominé dans la catégorie Cartes d'Extension et Périphériques

L'équipe éditoriale de PC Expert
procèdera à la remise des Prix d'Excellence Technique le

Mardi 16 janvier 2001

Dans l'attente de découvrir avec vous le Palmarès 2001

Joscelyn Flores
Rédacteur en Chef de PC Expert

26

Announcing Creativity Award for the Thumb Drive

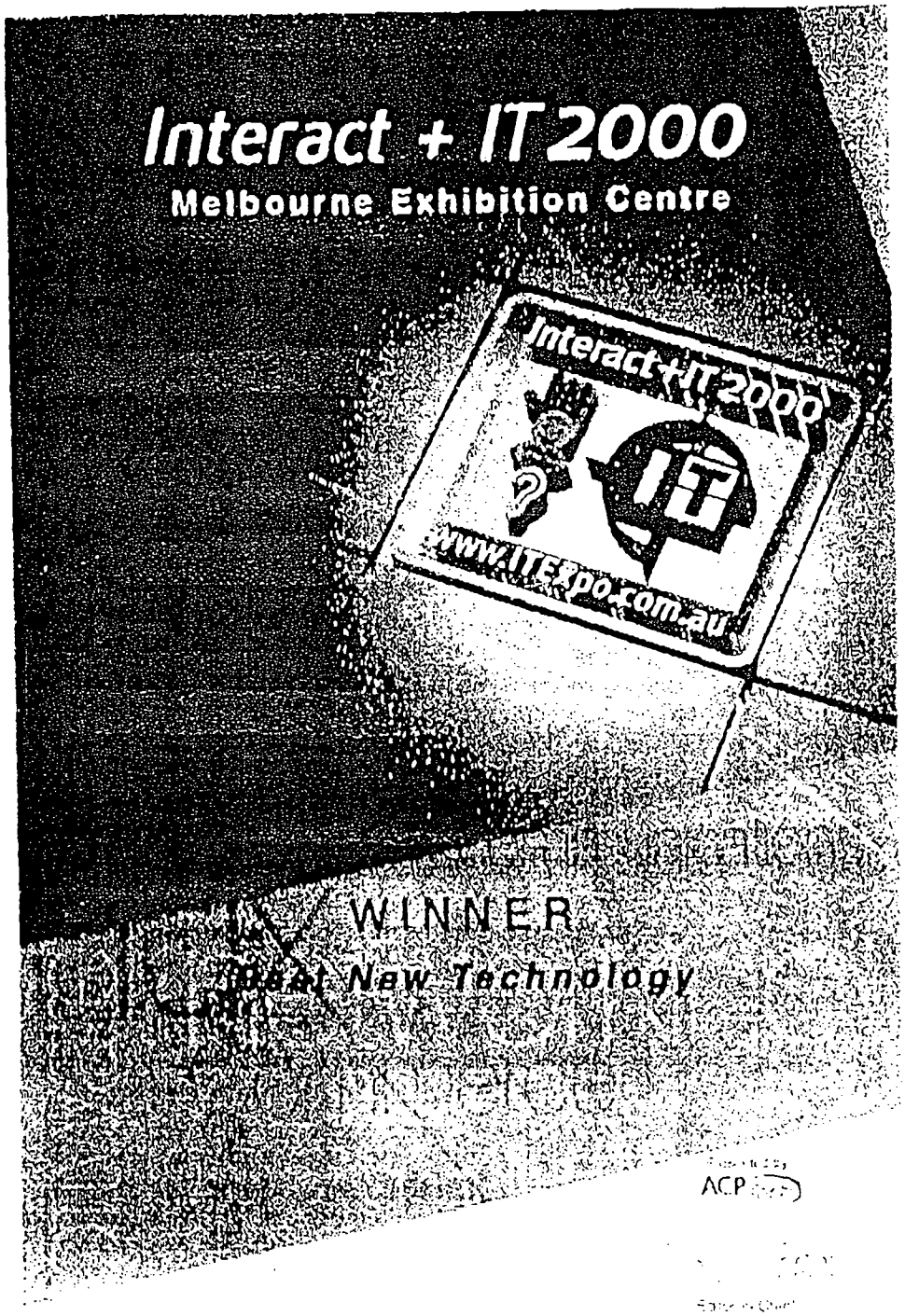
Dear Mr. Jirasak Prempojwattana

After testing and reviewing the Thumb Drive, we are pleased to give it our Creativity Award logo for its excellent design and usability. The logo simply shows that your product proves to be an innovative product and is officially endorsed by our magazine. We issued and announced such award for your product in our issue of Computer User Magazine Vol.83 of October 2000.

We value your participation and your trust in our magazine.

COMPUTER USER Creativity Award

With best regards,
Wirach Winitwatanawong
Editor of
Computer USER Magazine


Interact + IT 2000
Melbourne Exhibition Centre
Interact+IT 2000
WWW.ITEXPO.COM.AU
WINNER
Best New Technology
ACP

Chicago Computer Guide

SHOWTIME! - Part 3

by Wayne M. Krakau

Wayne is president of Krakau Business Computer Systems, Inc., a systems integration firm that is a Novell Gold Authorized and Novell IBM Host Master Authorized Reseller. He has been working with computers for 23 years. He holds an M.B.A. in Marketing and a B.S. in Information Science and was originally educated in Computer and Information Systems Analysis Engineering. He holds CNI, MCNE and CNTE ratings and all five of the original LANDA Certifications. Wayne can be reached for questions, comments, or topic suggestions at (847) 298-7695 or via E-mail to wkrakau@krakau-inc.com. For past columns and company information go to http://www.krakau-inc.com.

It's back to the trade shows, again. This time I'm covering the remainder of Spring COMDEX 2000 plus the recent Chicago Internet World 2000.

The major buzz in the Linux half of COMDEX was that Corel had the best Linux package. This is an observation on my part, not a technical opinion. There was also an underlying worry about the rumors, now confirmed, about financial problems at Corel. For the hobbyists and enthusiasts in the crowd, the idea of committing to a Linux vendor now, only to be forced to switch later was annoying, but not really that daunting.

Business users and their technical staff colleagues, however, have a lot more worries - like their jobs. For smaller businesses or departmental managers, the lack of in-house technical support could make a major change very expensive. For the corporate folks, whose LAN/PC support teams are typically too understaffed to handle the day-to-day running of the network, a corporate-wide conversion could be just as impractical. Hey, who ever said that business computing was easy? Besides, there seems to be a rather large personnel shortage in the food service industry. Would you like fries with that?

The most impressive bit of hardware technology at COMDEX was also the smallest. It's called the ThumbDrive, from Trek 2000 International, Ltd. (www.thumbdrive.com). The idea for this device is so clever and so handy that I'm surprised that nobody else has thought of it before. It consists of a small DIP-style (Dual Inline Package) chip embedded in a plastic housing with a male USB (Universal Serial Bus) connector sticking out one end. That connector is plugged into a USB socket on any recently manufactured desktop or laptop computer, either directly, or via a USB hub.

Once you've stuck the ThumbDrive into a USB port, what have you got? You've got an ultra high speed "disk drive" holding from 8MB to 256MB of data (with 512MB available soon), depending on the model, in a finger-sized device that is practically indestructible, based on normal office and travel handling. In principle, it should be impervious to most low and medium level electromagnetic interference. (Just, don't try to use it in place of a spark plug!) In terms of physical durability, you would probably have to stomp on one to break it.

you need to make the ThumbDrive work is Windows 9x and the small device driver provided with e product (and also downloadable). After that, anytime you plug in the device, it immediately shows up as an additional drive within Windows Explorer. Unplug it and the drive letter disappears.

The ThumbDrive is made specifically for data transfer. Since each one cost more than an entire Zip Drive ($399 for 128MB), they are not practical for general purpose storage. However, their simplicity and durability make them ideal for transferring files between computers.

I have to admit that much of the allure of the ThumbDrive is its geek-appeal. For a gadget-freak like me, a tiny, durable, hard drive-equivalent, with a catchy name, and literally the size of a thumb, is almost irresistible. Besides, you can plug 16, 128, 265, 64 and 32MB ThumbDrives, respectively, into a five-port USB hub and pretend you are in the Outer Limits episode (the original series, not the current one) about the fugitive with the computer hand with removable fingers!

Well, how about Internet World 2000? My general opinion can be summarized in one word - yawn. How many times can you see a booth claiming to be the best and (naturally) most technologically advanced method of [Fill in the blank: e-commerce site hosting; e-commerce software; e-commerce consulting; e-commerce payment software; e-commerce payment services; Web site hosting; Web site design; etc.].

To be honest, the fact that all of these solutions looked identical (at least within their own categories) may be more a matter of weak marketing skills than actual quality. It seems that marketing folks, unlike computer types, aren't that willing to work themselves nearly to death for a combination of minimum wages (if that) and the promise of (currently worthless) stock.

What's worse is that many booths had such generic displays that I couldn't figure out what they did! I know that cars have been marketed with commercials showing nothing more substantial than scenes of rolling hills without actually displaying a car, but a computer trade show is not the place to get so esoteric that the attendees aren't motivated to investigate your exhibit.

The only truly innovative product that I saw was a collection of wearable computing devices by Charmed Technology (www.charmed.com). Innovative - yes. Useful for any of my clients - no. Useful at a high-tech pirate-themed costume party - possibly, due to the eyepatch-looking monitors their models were wearing.

My final impression of the show was inspired by the three models at the Charmed Technology booth. They kept getting together and whispering among themselves. In my warped imagination the conversation went like this:

First Model: Wow! Get a load of that geek over there.

Second Model: Yeah. Isn't he just the worst nerd in this kingdom of nerds?

Third Model: Hey! I recognize him. He's one of those Internet millionaires.

First Model: He's mine - I saw him first!

Specials

Laptop special

Carry these with you

For on-the-road computing, bring along these adapters, storage cards and keyboards.

Computer Times
By Alfred Siew
22 Mar 2000

Road warriors, here are some things you must not forget to bring when going on the road.

Power adapters
Countries such as Germany use 230-volt power supplies, so you do not need to bring a transformer. If you are going to the US, you would need 115-volt power adapters and transformers. Plugging in the wrong adapter may damage your notebook.

Even if the voltage is similar to what is used here, consider also the type of socket. Australia, for example, needs unique three-pin jacks.

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Phone adapters
Accessing the World Wide Web in the business centre of a hotel is expensive so set up Internet roaming on your notebook.

Many hotel rooms now have a data line and a phone line for you to connect to your notebook's modem. However, phone jacks differ from country to country. For example, we use the RJ11 phone jack here.

You may also want to bring along a line extension Ñ especially when it means you can check e-mail from your bed!

Internet roaming
Internet roaming allows you to use your Internet access account overseas, without paying costly IDD charges.

If you are in the US, for example, you simply connect to the Internet by dialing a US phone number instead of a Singapore number. Using Internet roaming software like GRIC or iPass, you log on to the Web using your Singnet, PacNet and StarHub username and password and access the Web locally from there.

Each of these Internet service providers have low auto-roaming rates. Singnet roaming charges range from $0.10 to $0.25 per minute.

And once you have an Internet connection up and running, you may use Media-Ring's software to dial home via the Internet, rather than make an expensive IDD call. Just get a cheap micorphone.

Other accessories

For the Palm user who needs to type on the Palm organiser, get the Palm portable Qwerty keyboard for $179 which can be folded up when not needed.

Also check out Palm's auto/air rechargers (each $75) which can charge up your Palm IIIc when you are driving or flying.

If you want handy, portable storage, you might want to try out Trek's Thumb Drive which will be available within the next few months. Weighing a mere 30g, this flash memory device stores up to 256MB of data and connects to any USB port.

Also, make sure you have brought enough flash memory cards - be it Smart Media or Compact Flash - when you intend to take lots of digital photos.

Finally, pack along a handy mouse in your notebook bag - you won't know when it will come into good use.

<Next>

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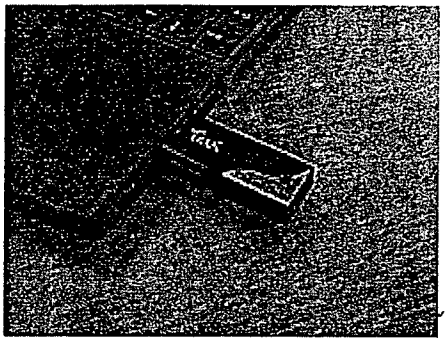
Trek ThumbDrive USB

Plug-in Solid-state Storage

by Stephen Jones (April 20, 2000)



While it looks like one of those annoying security "dongles" for unlocking pricey software, the Trek ThumbDrive is actually an attractive alternative to all those monosyllabic, mobile megabyte machines: Zip, Jaz, Clik!, and Orb.

The idea couldn't be simpler: No power supply. No external cables. No drive mechanism to wear out. Just a thumb-sized package packed with eight to 512 megabytes of nonvolatile RAM that acts like an extra drive when plugged into any available USB port.

Retail pricing has not been set but the 128MB ThumbDrive is available now, with 256MB and 512MB ThumbDrives coming this Summer and Fall.

Dimensions: 57mm(L) x 17mm(W) x 10mm(H)
Weight: 30 grams

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Trek ThumbDrive 32MB

By tachyon Category : Storage

Approved by Jimmy Tang on Tuesday, 23rd of May, 2000
Rating : 3.5 out of 5 Stars, Price: S$159

Trek ThumbDrive Specifications

Features	O Fits standard USB port. O No cables or PCMCIA card adapters required. O Conforms to USB mechanical specifications. O Plug & Play. No battery or power source needed. O Runs on Microsoft Windows 98 or later versions. O Usable with desktops & notebooks. O Storage capacities available from 8MB to 256MB.
Physical Specifications	O Size : 57mm (L) x 17mm (W) x 10mm (H) O Weight : 30g

Introduction

Interesting as the name may sound, the Thumbdrive is indeed about as big as a thumb. It isn't really a drive as the name suggests, but the name brings to mind the mechanical versions which we are all familiar with. Instead it is a solid-state device employing flash memory commonly used in Compact Flash cards, SmartMedia, MMC, MemoryStick etc. The drive also uses the USB as the interface to the PC. The USB standard also

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classifies these devices under the storage class. This simplifies and standardises the protocol used to control and transfer data to and from the device.

It's all you need to get started.

It's a Stick of Gum

At first look, the Thumbdrive looks like a pack of 5 stick of gum except that it is packaged in black. At least the version that we received for the review was black in color. I believe the Thumbdrive also comes in different colors, even translucent colors like the iMac. It is quite a neat and compact package. To most people, it doesn't look like anything that resembles a PC peripheral let alone a drive. With the cap on, it neatly hides the USB connector from view making it look more like just a piece of black plastic. Kind of reminds me of those lead refill case for mechanical pencils, yeah, remember those ? That's what it looks like except a little fatter and thicker. At the other end of the USB connector, there is a little write protect switch in a small cavity which allows the user to protect the data in the Thumbdrive from being accidentally erased. Quite a neat feature much like the write protect tab of the regular floppy disk except that this switch is a little difficult to access with you fingers. The cavity is really quite small and it is quite impossible to use your fingers to access the switch. I could only do it with a pen tip.

The ThumbDrive plugged into the USB port.

Or, you can always plug it into the Microsoft Natural Keyboard Pro's built-in USB hub.

Hand me that Thumbdrive

Do not under estimate the Thumbdrive, it is capable of storing a whopping 256MB (that is the projected capacity for future versions). The version that we had for the review only had 32MB which isn't really too bad but a tad bit too small compared to a Zip disk. It certainly beats carrying a Zip disk though. You don't even need a drive to read the contents, just a USB host. At 32MB, I could store quite a number of JPEG images, approximately 30 minutes of MP3 music, numerous electronic books or files. The data transfer rate of the Thumbdrive is really limited by the USB. Reading from the Thumbdrive is quicker than writing to it since flash memory has limited writing speed while reading from it is as fast as reading from a ROM. The read speed averaged approximately 655KB/s while the write speed averaged about 350KB/s. The access speed is about 30ms. These numbers were obtained using WinBench Disk Inpection tests. I also did some manual timing tests to verify the accuracy of the test results on this rather unconventional drive. The results were almost the same.

motherboard (21/07/2001)
Canon CanoScan D2400UF (17/07/2001)
The CLAW Gaming Controller (12/07/2001)
SUMA Platinum GeForce2 MX 400 32MB SDRAM (11/07/2001)
Hitachi DZ-MV100E DVD-RAM Camcorder (10/07/2001)
Hauppauge WinTV PVR PCI (09/07/2001)
The Icemat mousepad (08/07/2001)
Canopus Firebird RZ (07/07/2001)

The ThumbDrive listed in the Device Manager as a Netac U.F.D drive.

Write protect tab to prevent accidental loss of data.

Final Thoughts

The Thumbdrive is certainly a pretty innovative and nifty product. The Thumbdrive tries to be unique and targets the PC users but with the already varied solid state memory products available in the market today for a multitude of consumer electronic products, users are not content with just able to transfer data from one PC to another using such a device as the Thumbdrive. They would want to be able to keep to one type of media like Compact Flash or MemoryStick and be able to use these media to exchange data with different devices which uses the same type of media. Although the Thumbdrive does away with the need of a reader or drive, it does require a USB host device to control and interface with it in order for it to work. In this case, PCs are required for the Thumbdrive to work whereas devices such as digital cameras, PDAs, MP3 players etc does not and are usually client devices with respect to PCs. It is only made for the PC running Windows 98, and will not work under Windows 2000 or even the Macintosh. Let's hope they will have device drivers for other platforms in the future.

I would recommend the Thumbdrive if a convenient, reliable and compact media is required to transfer data between PCs where using the network is not an option. It is also ideal for sending data in a secure manner without going through the Internet. At S$99 for 16MB and S$159 for 32MB, it doesn't come cheap and the capacity is also quite low considering the hard disk that is available today comes in gigabytes. Hopefully the cost of flash memory lowers in the near future. Since flash memory is also widely used in many other similar type of memory products, the price is determined by the supply and demand in the market, pretty much like what we are seeing in the RAM market today. It probably doesn't make a lot of sense for the average computer user in terms of the cost involved but for the corporate and notebook user, it may be more convenient and efficient in the long run.

Test System configuration

CPU : Intel Pentium II 450MHz
Mainboard : ECS P6BX-A+
Memory : 128MB PC100 SDRAM
Harddisk : Western Digital 20.5GB
Video Card : Creative TNT2
Operating System : Windows 98 Second Edition

Join in the discussion of this article

Computing

First Look: Trek Thumbdrive

A Hard Drive the Size of your Thumb

By Matt Hooks - 06/29/00
Print Article - **Email Article** - **Post Your Comments**

Trek Thumbdrive - Trek 2000 International, Ltd. 30 Loyang Way #07-13/14/15 Loyang Industrial Estate Singapore 508769 - **www.thumbdrive.com** - **sales@thumbdrive.com**

Photo Courtesy of Trek 2000 International, Ltd.

In the search for a new way to store data, Trek 2000 International has created the Trek Thumbdrive - a portable hard drive the size of your thumb. Plugging into the USB port on the back or side of your personal computer or laptop, the Trek Thumbdrive can store between 8 and 512 megabytes of data. This is more than enough to transfer even the largest multimedia files. The best part about the Thumbdrive is that "no software, no connection wire and no battery are required" - the drive is automatically configured using Plug and Play protocol through a USB port. The drive also contains no moving parts so mechanical failure is a thing of the past.

As of yet, only the 8 through 128-megabyte models of the Trek Thumbdrive are available, but starting in May of 2000, and then in October or November of 2000, the 256 and 512-megabyte models will be available. Visit the company's website, www.thumbdrive.com, for more information.

How cool do you rate this product?

○1 ○2 ○3 ○4 ○5 ○6 ○7 ○8 ○9 ○10 Rate

Current Rating: 9.0

Comments:

eee by *eee*

eee

Trek USB Thumb Drive by *ewheetley@mac.com*

I will buy a Thumbdrive as soon as they come out with a Mac driver

Trek ThumbDrive by *cheristan@yahoo.com*

Trek's ThumbDrive supports Mac O.S already!

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Trek ThumbDrive

★ ★ ★ ★ ☆

By James L. Kim
July 14, 2000

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The *Trek Thumbdrive* death of the floppy drive is a painfully slow process. Apple has already discarded the notion, and the fledgling CD-RW will no doubt soon dominate the removable media scene. Meanwhile, Trek, a virtually unknown company from Singapore has created an amazing little "hard drive" that plugs directly into any USB port. Besides being ultra portable, the ThumbDrive has high storage capacity-- enough to put the 1.44-MB floppy out to pasture for good.

Trek Thumbdrive

- IBM to Offer 1-GB Hard Drive for Handhelds
- LaCie PocketDrive
- Iomega Zip 100 Portable USB Drive
- I-drive: Free Online Storage

No larger than a thumb, the 30-gram ThumbDrive is currently available in 8MB, 16MB, 32MB, 64MB, and 128MB sizes. Soon there will be a gargantuan 256MB version. Unlike IBM's 340MB MicroDrive, the ThumbDrive is solid state, meaning there are no moving parts to break.

Data transfer speed is lightning quick, reading at 700 Kbytes per second and writing at 350 Kbytes per second. Our laptop was able to read nearly 16MB of data from our 16MB test unit in about 25 seconds. A full floppy takes well over a minute. Also, unlike Smart Media, Compact Flash, and other forms of solid-state removable media that requires some sort of adapter, the ThumbDrive requires only an open USB port. This universality will take this drive a long way. That the drive is bus powered (powered by computer) makes this an even more intriguing product. The ThumbDrive currently uses USB 1.1 technology-- but the

company's working on a faster USB 2.0 version.

16MB for $70 is not cheap, especially if you're in the habit of losing things. A 16MB SmartMedia card costs about $50. But, imagine inconspicuously carrying around 256MB of memory in a device that won't even make a real dent in your pocket. It reminds us of a gadget out of a spy thriller. You even get a necklace holder to carry your ThumbDrive around in. The only complaint so far is the fact that the device is not password protected. Anyone who finds it could have access to your data.

The press release states that no software is needed, but you will need to load a driver, available on included floppy and the website (thumbdrive.com). Currently, the ThumbDrive is Windows 98 only; Mac, Windows CE, and Linux versions will be out soon.

Company: Trek 2000 International, Ltd., US reseller: usbdrive.com
Telephone: 65.5463933 (Singapore)
Price: $69.95 for the 16MB version
Availability: Now
Category: Storage
Platform: Windows 98
System Requirements: Pentium 100 MHz or higher, USB port
Specs: 30 grams

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Until the PC spec uncludes the ... - *Steven Vohl*

MIStupid.com
The Online Knowledge Magazine

www.thumbdrive.com

List Pricing:

8MB	$54.99
[illegible]B	$63.99
32MB	$103.99
64MB	$173.99
128MB	$299.99
256MB	$599.99

Rating

Features ★★★★★
Functionality ★★★★★

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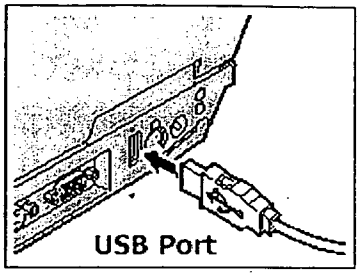
[illegible]nb Drive - 8MB Memory Card
Thumb Drive 64MB Memory Card

and

TigerDirect.com

ThumbDrive USB Storage Device

The ThumbDrive is a thumb-sized, removable storage device varying in capacities from 8MB to 512MB that requires no power or software outside of the one time device driver.



The Universal Serial Bus (USB) has begun to replace the old 9-pin serial port, and many new devices are now using it. The benefits of the USB port are its plug-and-play abilities and higher data transfer rates. (up to 12 Mbit/sec) The ThumbDrive takes an innovative approach to using the USB port by plugging directly into it. No connection cable is necessary. This works great on laptops and desktop computers that have placed a USB port in the front of the unit. Some PCs have placed the USB port in the back which may require a bit of fumbling around with cables.

One slightly misleading statement of this product is that "no software is required." Although it is true that no software is needed to operate the device, a device driver must be installed on any PC that will be using the ThumbDrive. The driver is small and easily available on the included floppy disk or the http://www.mistupid.com/cgi-local/redirect.cgi?http://www.thumbdrive.com website.

Once the driver is installed, the ThumbDrive can be plugged in and out of computers while they are on, as long as it is not read or written to at the time. When plugged in, the ThumbDrive appears as a removable storage device in your *My Computer* folder. Files can then be copied to and from, or saved directly through an application using its assigned drive letter (i.e. **E:**). ThumbDrive Secure is another version of the product that provides password protection to access the files stored upon it. Currently, the only operating systems that can utilize the ThumbDrive are Windows 98, Windows 98SE, Windows ME, and Windows 2000.

The ThumbDrive is a cool little device that can be invaluable when needing to transfer files that are larger than a normal floppy disk. Easier than a ZIP drive and quicker than e-mailing files, the ThumbDrive can be used to back-up files, bring them home from work, or carry large presentation files in your pocket.

FIRST LOOKS
STORAGE DEVICE

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ThumbDrive

Pros Portability; ease of use; up to 256MB storage.

Cons Cost per MB is expensive.

Verdict Incredibly small storage device, but comes at a price.

Price as reviewed (ex. VAT) £38

BEING ABLE TO DOWNLOAD just about anything from the Internet, plus ever-increasing file sizes, means that transporting your data has become an issue. Zip drives have given us a good solution, but you've got to carry the drive and the disks with you. The ThumbDrive is billed as the world's smallest storage device, and this tiny unit will give you quick and easy access to your data when you're on the move.

The device measures just 57 by 17 by 10mm, weighs just 30g, and is slightly smaller than a typical cigarette lighter. The ThumbDrive is a flash memory device and connects to your desktop or notebook via a USB port. No additional adapters, power, batteries, cables or card readers are required. A disk-write protection switch at one end of the device helps to protect your data from being overwritten and Datamind claims information stored on the ThumbDrive can be preserved for up to 10 years.

The ThumbDrive is a hot pluggable device with Windows 98/SE and 2000 Professional. There are also plans to include support for Linux, Macintosh and Palm.

While the ThumbDrive is not as fast as an external hard disk drive, it claims to have a read speed (ThumbDrive to PC) of 0.7MB/s and a write speed (PC to ThumbDrive) of 0.35MB/s.

Our review unit transferred 7.2MB of data from a PC hard disk drive running Windows 98SE to the ThumbDrive in 24 seconds, and then copied it back to the PC in 14 seconds (faster than any floppy disk or Zip drive).

There are currently six models available, including 8MB, 16MB,

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ThumbDrive

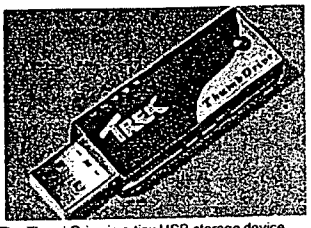
32MB, 64MB, 128MB and 256MB configurations.

Convenience however, doesn't come cheap. With a starting price of £38 (ex. VAT) for 8MB, scaling up to the 256MB version at £625 (ex.VAT), you have to ask yourself whether the ThumbDrive is really a cost-effective solution. However, if portability is your main concern, you can't get more portable than this. ashley mckinnon

Distributed by Datamind 39 Seymour Road, Ringwood, Hampshire BH24 1SQ

(0800) 870 1416

http://www.thumbdrive.org.uk/



The ThumbDrive is a tiny USB storage device that has a capacity of 8MB to 256MB. No extra adapters, power, batteries, cables or card readers are needed to transfer data from your PC to the ThumbDrive and back again.

This article appears in the February 2001 issue of *PC Magazine*

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Trekstor 16MB Thumbdrive Smart Review

Review by Paul Machado on June 12, 2002

Product Supplied By: Trekstor
Retail Price: $80CDN, $50USD

Company Overview:

Trek 2000 Ltd, a pioneer in mobile storage solution, was founded in 1989. In Feb 2000, Trek introduced the Thumbdrive, a portable USB-powered solid-state storage solution that brought about the beginning of the end of floppy drives.

The market for USB-powered solid-state storage solution is projected to grow exponentially in the coming years, as more businesses and consumers seek greater storage, reliability and robustness. Started as a business solution largely used by professionals, Trek sees the consumer market for the solution ready to explode, with the technologies maturing and the increasing trend of data availability on the go. Trek's Thumbdrive products are sold in more than 25 countries.

The Thumbdrives are growing increasingly pervasive as security and privacy becomes ever more important. As more people rely on computers and Internet to access and create information, personal secure storage will attain higher acceptance. The Thumbdrives combined with biometric and encryption technologies are the ideal individual data storage solution, offering protection against intrusion.

Product Introduction:

In this new age of technology products are getting smaller, smarter and more convenient for end users. Technology has become part of our everyday lifestyle. Such things as cell phones, PDA's, and laptops are all designed with ease of portability in mind. They are made light, small and designed to go wherever you go. There is a new trend in town and that is being able to carry amounts of data around with you to be able to access elsewhere. The leading product in this trend is the Thumbdrive. Trek USA is one of the leading companies to offer products of this new trend. Their Thumbdrive products offer great portability with its thumb size design and ease of use. With its USB interface data can be transferred quickly and simply without having to load any drivers (except for Windows 98 and 98SE) which makes this product stand above the competition.

Product Specifications:

Interface	USB Specification 1.1
Memory	8MB / 16MB / 32MB / 64MB / 128MB

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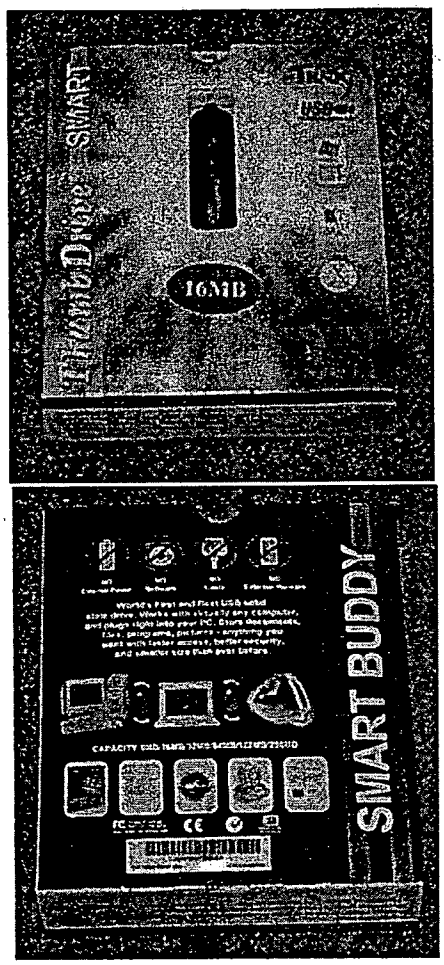
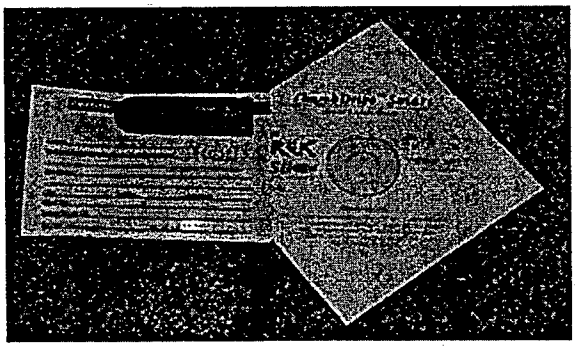
Dimensions	64mm(L) x 18mm(W) x 8mm(H)
Weight	12g
Data Transfer speed	Read Operation: 700 Kbytes/s Write Operation: 350 Kbytes/s
Power supply	USB bus-powered
LED indication	Solid: Thumbdrive connected Blinking: Data transmitting and receiving
Operating Temperature	0°C ~ 50°C
Storage Temperature	-20°C ~ 80°C
Relative Humidity	During Operation: 20% ~ 80% During Storage: 5% ~ 95%
Certification	FCC, CE, VCCI, CTICK, BSMI, MIC

Product Packaging:



The Thumbdrive comes packed in a box much larger than itself. Complete with a window to display the Thumbdrive itself this product sure would look great on store shelves. Included with the Thumbdrive is a driver CD for systems with older operations systems (ie. Wondows 98) and the electronic manual, a warranty card, a label and the product itself.



Lets now have a look at some of the features offered with the Thumbdrive SMART.

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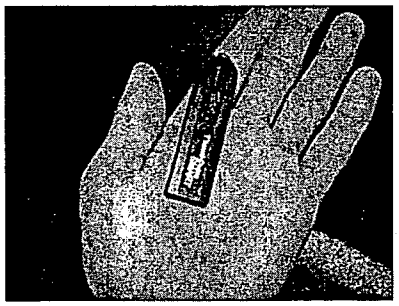
Trekstor 16MB Thumbdrive Smart Review

Review by Paul Machado on June 12, 2002

Product Supplied By: Trekstor
Retail Price: $80CDN, $50USD

Product Features:

As you can see they best feature of the Trekstor SMART Thumbdrive is its size. With dimensions of 64mm in length, 18mm wide, and 8mm thick. This is one very small storage device, in which the name speaks for itself. Also weighing only 12grams it adds to this products great functionality and portability.



Another great feature with the Thumbdrive SMART is that fact that it is comprised of a USB Plug & Play interface. This offers great speeds when transferring and copying data and also adds great ease of use. There are no worries about having to install drivers (except for Win98). This makes it much easier and quicker to copy, transfer any files you need quickly onto or off of the drive. The device utilizes USB 1.1 which has a maximum speed of 12MBit/sec. This is one feature I would have liked to be USB 2.0, especially for larger versions of the drive. But even at the USB 1.1 specification, the device transfer files fast. The ThumbDrive SMART is available in capacity versions of 8MB/16MB/32MB/64MB/128MB.

A small but yet important feature of this particular Thumbdrive is the write-protection tab located at the rear of the drive. Just like on a floppy diskette this allows you to prevent accidental deletes of any files on the drive. Also located to near the write protect tab is a LED indicator. Just like a HD LED indicator this LED flashes when data is being transferred or copied off of the drive. When the drive is put into a USB port the LED flashes slowly indicating that the drive is ready for usage.

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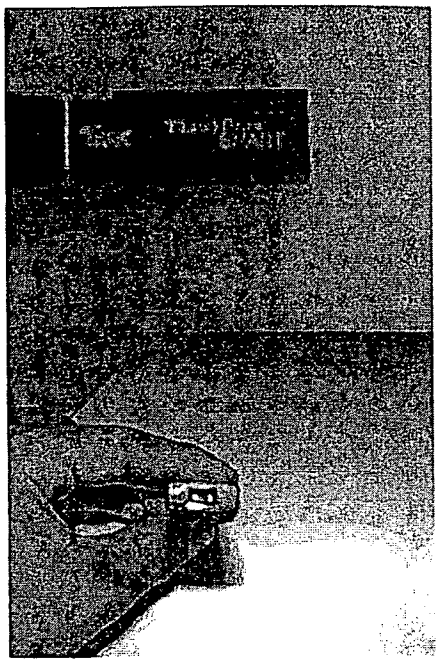

Now lets see how well this drive performs and conclude the review.

Testing + Conclusion

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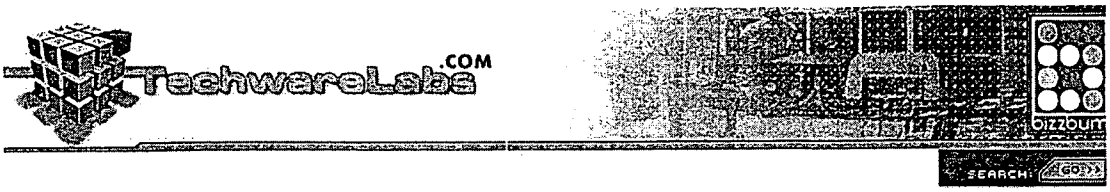

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Trekstor 16MB Thumbdrive Smart Review

Review by Paul Machado on June 5, 2002

Product Supplied By: Trekstor
Retail Price: $80CDN, $50USD

Product Testing:

The Thumbdrive SMART is capable of 700Kbytes/s read operation and 350Kbytes/s write operation. Compared to other removable storage devices such as Zip drives this may seem slow but they are designed for completely different uses. The Thumbdrive is designed for ultra-portability and some speed as well while a Zip drive is mostly designed for speed. Writing a 10MB file onto the drive took just over a minute. Now to compare this against a floppy drive I used a 1MB file to gather average write speeds. It took 6 seconds with the Thumbdrive to write the file while the Floppy drive took 33 seconds. This clearly shows that this drive is much faster than a floppy drive.

Conclusion:

I have never been able to transfer these amounts of data so quickly and easily. With the Plug & Play USB interface it makes it so easy to transfer data from one computer to another without having to large any large piece of hardware around. Although the speed is not incredible it is still quite fast. Though I do not mind the speed since it is so portable. Features such as a write protect tab, status LED and a Plug & Play interface I highly recommend this product to people who constantly need to transfer files from one computer to another.

Product Score Breakdown:

Features:	**8/10**
Ease of Use:	**9/10**
Design:	**10/10**
Performance:	**7/10**
Overall:	**9/10**

Pros:

- No drivers (except for older OS)
- Small size, light design
- Great Ease of Use
- Available up to 128MB

Cons:

- No Security software
- Not USB 2.0

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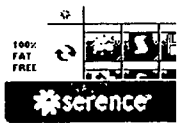

DealTime.

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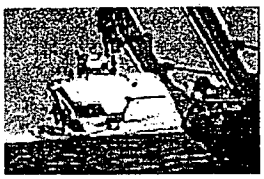

How the ThumbDrive helped Alvin, the deepest diving manned submersible in the United States.

The Deep Submergence Vehicle Alvin is the deepest diving manned submersible in the United States, having a depth capability of 4,500 meters (~15,000 feet). The vehicle is operated as a National Facility by the Woods Hole Oceanographic Institution in support of deep ocean research conducted by scientists from throughout the world. The submersible normally makes approximately 175 dives per year carrying a pilot and two scientists within its seven-foot diameter personnel sphere. The submersible is equipped with a variety of sensors measuring ocean conditions as well as operational parameters. Additionally, most research programs involve the use of specifically designed tools and sensors that must be accommodated. Space within the personnel sphere is at a premium since it must house all the science and control electronics.

In order to meet the various navigation, control and research sensor requirements, six 750 mHz compact PCI computers along with their expansion cards and power supply have been installed in a single 19" rack. Unfortunately, space constraints prevented installing any removable data storage devices, which means all program downloads and updates must be done via an Ethernet connection. This is certainly viable but it greatly complicates code testing and evaluation, particularly since the submersible is not connected to the network during dives.

In an attempt to simplify the process used to complete code development and testing as well as facilitate supporting science applications, we purchased Tekstor USB ThumbDrives. These devices have more than met our expectations. Code is now transferred onto the submersible's computers in exactly the same manner as would be done if we had installed floppy drives except with greatly increased speed, capacity, and reliability. Since the ThumbDrives act as standard hard drives, we can frequently test code without actually installing it; instead the code can be run directly from the ThumbDrive. Finally, although hard drive failures are rare, ThumbDrives allow us to easily maintain an image of the critical directories for each computer, greatly facilitating repairs when necessary.

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SUCCESS STORIES

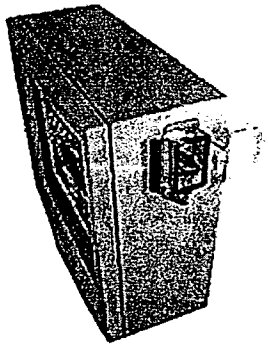
BUSINESS SOLUTIONS ■

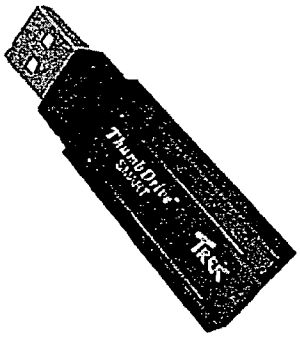
CONSUMER SOLUTIONS

SCHENCK AccuRate

How the ThumbDrive Smart helped SCHENCK AccuRate's CP-2 in the transfer of data.

SCHENCK AccuRate, a manufacturer of bulk solids metering equipment, has incorporated the ThumbDrive Smart into their CP-2 Operator Interface. The CP-2 is the platform for the DG2000 HMI Group Control used to operate up to 32 SCHENCK AccuRate feeders. The DG2000 software is Windows 2000 based and is easily configured to graphically display the number and type of feeding devices being controlled. The CP-2 incorporates the use of the ThumbDrive Smart for a quicker, more convenient way to store and update the custom program and configuration data.





Using a ThumbDrive Smart in the CP-2 offers SCHENCK AccuRate two distinct advantages over the traditional floppy drive. A floppy drive can be unreliable in extreme conditions and is significantly larger. Whereas, the ThumbDrive Smart is able to withstand extreme conditions and is smaller and lighter weight. Also, the USB driverless plug and play solid drive makes connecting to the CP-2 or the customer's PC hassle free.

Easy storage and transfer of the DG2000 custom configuration are attractive features of the ThumbDrive Smart. The CP-2 is sold with the customer's configuration stored on a ThumbDrive Smart. SCHENCK AccuRate also uses the ThumbDrive Smart to send the customer updated versions of the DG2000 software. An additional ThumbDrive can be purchased for the use of transferring process data. Data from the CP-2, such as events and parameters, can be easily saved on the ThumbDrive Smart and transferred to the customer's PC without the need of loading a driver. This eliminates service issues related to the loss of the driver floppy and inexperience of loading a Windows driver.

To find out more about SCHENCK AccuRate, visit their website at http://www.sarinc.com

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How the ThumbDrive provides RadVault with on-the-go data storage.

"I founded Radvault to empower doctors and patients themselves to control their vital medical imaging data, and to provide lifetime storage for these images and reports."

Peter Rothschild, M.D.
Founder
Rad Vault, Inc

Radvault has chosen ThumbDrive to be the personal companion. Now patients and professionals can store medical digital images in their ThumbDrives and carry it along with them in a key-chain. If the need arises, a viewer program in the ThumbDrive allows any doctor or hospital to see the images instantly making any assessment or correlative study a breeze. No more tagging along of bulky and expensive films and that's provided you can find them.

In some situations, it could be mission-critical as days and weeks of delay could make the difference between life and death. ThumbDrive could really save your day. Radvault offers lifetime storage of digital images but when you are on-the-go, ThumbDrive could be your most important companion.

For more information visit www.radvault.com

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SUCCESS STORIES

BUSINESS SOLUTIONS ■

CONSUMER SOLUTIONS

The ZYNX solutions, featuring the ThumbDrive.

Micro-Trak® Systems, a leading manufacturer of agricultural electronic monitoring and control equipment, is proud to introduce "ZYNXSolutions", the Guidance System and Sprayer Controller in One.

For more than 20 years, electronic systems have been used to improve farmers' productivity. The ZYNX System offers simultaneous multi-function operation; farmers can use the ZYNX Guidance Solution (the basis of precision farming) while the system controls all of the sprayer functions.

The ZYNX System offers complete touch-screen control. A fully featured DGPS system can help improve accuracy and create a saving of at least 10% off chemical and fertilizer bills. Not only is that a profitable deal for the farmer, but it also helps the environment by avoiding the over-application of chemicals. Definitely a win-win situation!

The leading-edge software in the ZYNX System is very user-friendly, and the interactive touch screen display features easy-to-understand graphics. The Trekstor ThumbDrive plays a vital role in the simplicity and compactness of the ZYNX System. Jobs can be conveniently downloaded and transferred between the farmer's PC and his ZYNX System. The ZYNX System console is installed in a tractor cab, so space and maneuverability are limited.

Another great benefit of the ThumbDrive feature is that allows easy upgrading of the different product interface software. Micro-Trak provides upgrades via the Internet or CD for easy downloading to a PC. Follow that with a simple transfer via ThumbDrive to the ZYNX, and the farmer is ready to go out into the field knowing he has the most current software for his different data requirements.

It is easy to see that for convenience and accuracy, the ThumbDrive feature offered in the ZYNX Solutions, is an integral part of its success and long-term viability in the farmers' fields.

Visit www.micro-trak.com today, for more information on Micro-Trak and its ZYNX Solutions!

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Reviews

Thumbs up for Trek

By W.D. Yang

Product: Trek Thumb USB Drive
Price: Price not available
Pub Computer Times 28/06/2000

Tried & Tested:
The Thumb Drive is a competant performer, but Trek needs to work on the packaging of its groundbreaking storage product.

The software drivers for the Thumb Drive are extremely easy to install. Just plug in the media and you are ready to go. In the transfer test, 14.2MB of data in 45 files but one folder, take 50 seconds to transfer from a Pentium II 266MHz Dell Inspiron 3200.

Rated at 700KB/s for data read, depending on the speed of the PC, the Thumb Drive is a competant performer.

Data writes are rated at a decent 350KB/s. No external power source is needed as the Thumb Drive taps electricity directly from the USB port. The Thumb Drive is as long as a bus ticket and weighs just 30g.

Depending on where the USB port of your notebook is located, it can be vulnerable to damage.

The company needs to ramp up its capacity fast in order for it to be a serious contender in the laptop storage market. The lack of a bundled software is not a hinderance as it effectively uses the Windows disk management system to access/manipulate files.

Trek needs to work on the packaging of its groundbreaking storage product. There was a dearth of good documentation and users could really do with some advice on how to take care of the Thumb Drives.

Thumb Drives come in storage sizes of 16MB (uncompressed) to 128MB.

Other reviews:
High capacity media and drives:
Hewlett-Packard CDwriter plus 8210e | Iomega ZipCD 650 | Creative CD-RW 8432x | Hewlett-Packard CDWriter 9310I | Iomega ZipCD 650 USB | Sony CRX145E-B 9310I | Iomega Jaz2GB SCSI | Orb drive 2.2GB SCS
Low capacity media and drives:
| Iomega Zip 100 USB | Iomega 40MB Clik! | Memory Stick USB reader | Trek Thumb USB Drive

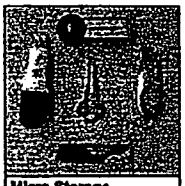
SERVING SANTA BARBARA, VENTURA AND SAN LUIS OBISPO COUNTIES May 2002

Tools, Tips, Tricks, & Traps
Mini Marvels Put Hard Drives on Your Key Ring
By Bob Arlow

Imagine carrying your PowerPoint presentation or digital sales catalog across the country-without schlepping your laptop-by just hanging them on your key chain. Imagine dropping data, photographs, music and video files, e-books, and documents into your pocket and moving them seamlessly and effortlessly across the boundaries between PC and Mac.

Imagine you're an MIS manager carrying an array of files or start-up utilities clipped to your shirt pocket.

Well, imagine no more. Tiny pocketable hard drives that store anywhere from 16MB to 1GB are now available from half a dozen companies. About the size of 5-stick pack of gum, they have no moving parts and don't need power or batteries. Nonvolatile flash memory stores data safely for up to 10 years.


Micro Storage (clockwise from left) DiskOnKey, USB Drive, QDrive, and ThumbDrive.

These little wonders require only a Universal Serial Bus (USB) port. Some are even bootable, so you can run multiple applications from them. No drivers are required for newer versions of Windows, Mac, and Linux.

Totally plug-and-play, they operate on the fly. Plug one into a USB port, and your computer sees it as another hard drive. Whatever's on these elegantly simple solid-state storage devices will run directly, without copying to the host's hard drive. To move data between computer and tiny drive, merely drag-and-drop.
(Designers take note: these units don't--but should--show up in the "Send to" field of Windows' right-click context menu.)

DiskOnKey
This unit's patented design makes it the only one with a built-in central processing unit (CPU). This allows for future applications and provides an automatic boot function for computers running the widely used Phoenix BIOS (Basic Input Output System).

Speed is another plus for DiskOnKey: according to the company, 1MB/second read or write data transfer. Better and more secure than a write-protect switch, DiskOnKey offers a unique KeySafe utility, downloadable from the Web site (www.diskonkey.com). With it, a user can set aside up to 90 percent of the unit's memory for a password-protected "Privacy Zone."

DiskOnKey sports a key ring and pocket clip on the cap, and is available on line at its Web site or through Dell, Compaq, and IBM. Capacities and suggested prices range from 8MB for $30 to 128GB for $150.

Q Drive
The first mini drive to be introduced in the U.S., in late 2000, the Q Drive is now in its second generation. Its array of bright colors and styling (see photo) make it the least stodgy of the group. When I looked at the first version a year ago, my positive review reflected the "wow" factor of the new technology, even though Q still had some rough edges.

Unfortunately, it still does, and although they're not disabling, the company (www.agatetech.com) ought to address them. Surprisingly, the write-protect switch has been dropped, so there seemed to be no way to protect data-until the company's P.R. person alerted me to the Q Utility file that pops up when you double-click on the Q drive icon, offering write protection and password-protection.

Q Utility is probably documented on the floppy disk that's supposed to contain HTML and PDF versions of the user's guide, but mine was blank. The box label says the manual can be downloaded from its site. Uh-uh, it's not there, either.

Q is the most expensive of the tiny drives: 16MB for $70, 64MB for $200, 128MB for $300. So it's surprising that claimed read/write speeds are slower than the other minis:

700KB and 350KB per second, respectively, and the packaging and enclosures are rather crude.

ThumbDrive
The one that started it all, ThumbDrive, was introduced two years ago at the venerable CeBIT, world's largest I.T. trade show, in Hanover, Germany.

These units come in two flavors: driverless and ThumbDrive Secure, the latter of which includes software that generates a "Security Code" log-on screen. Both models incorporate a write-protect lock to prevent accidental erasure.

Selected sizes and approximate prices for the driverless run from 16MB for $55 to 256MB for $470. ThumbDrive Secure prices vary slightly from these.

Currently in development is ThumbDrive Touch, a fascinating innovation using biometric technology. Forget lost passwords--the unit will incorporate a fingerprint reader for really secure data!

USBDrive
In addition to its pocket clip and key ring adapter, the USBDrive can make a fashion statement--it includes a neck cord so that you can wear your data. A nice touch that competitors ought to emulate is the included USB extension cord, which means that a user without hub or front port needn't climb behind the computer.

USBDrive provides a useful formatting utility on the included CD (though it's not mentioned in any of the materials). A write-protect switch secures data, and transfer rates are zippy-over 1MB per second read speed and 800KB per second write, according to company specs.

Prices are within range of the competition, or slightly less. See www.usbdrive.com/partners_resellers.htm.

But the best feature of USBDrive is innovation. It's the only one that offers a 1GB drive--though with very hefty $900 price tag.
And in March, the company will debut the first tiny drive compliant with the new USB 2.0 standard--for data transfer rates about 15 times faster.

New Kid on the Block
You may have noticed that these petite portables--particularly at higher capacities--are pretty pricey, especially compared to other forms of portable memory. But that may be changing. A new player, the driverless Pen Drive (www.eportables.com) comes complete with a write-protect switch and all the frills (pocket clip, key ring hole, and LED indicator), but is quite affordable: the 32MB unit lists for $39.99, 64MB for $59.99; 128MB for $89, and 256MB for $149.

Bottom Line
These devices are a great way to move data effortlessly between machines and operating systems. In my tests, all the units worked flawlessly. One caveat, however: If you have to edit a file that's on the mini, move the file to a hard drive first; I had a Word document turn to mush when it was edited on the mini.

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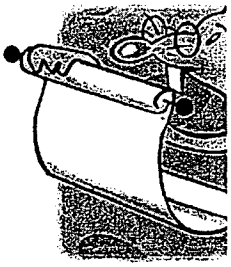

February, 2000

See also:- current STORAGEsearch - News, STORAGEsearch news archive - January, SPARC Product Directory - news Articles, Storage manufacturers, Industry Trade Associations & other info sources, Tape drives & systems, Hard drives, RAID systems, Data recovery services

Megabyte loved reading news about computer technology

Martinsried/Munich, Germany. February 29, 2000 - **ADVA AG Optical Networking** today announced the signing of a definitive agreement to acquire Storage Area Networks (SAN) Ltd., a leading privately-held U.K.-based designer and manufacturer of intelligent storage area network gateways. - This acquisition strengthens ADVA's leadership position in the enterprise and metro access optical networking market by adding complementary products to ADVA's portfolio. In addition, SAN provides ADVA with in-depth knowledge about switching and routing technology for storage area networking applications, Fibre Channel protocol, and transmitting information over longer distances to remote storage facilities. Under the terms of the agreement, the acquisition will be made at a total purchase price of approximately $83 million United States Dollars (USD).

"This is an important first acquisition in ADVA's growth strategy, which complements and strengthens our leadership position in the enterprise and metro access optical networking market," said Brian L. Protiva, ADVA's Chief Strategy Officer. "By adding SAN's technology to our Dense Wavelength Division Multiplexing (DWDM) and intelligent optical networking solutions, we are now not only able to offer full wire-speed transparent Fibre Channel optical channels up to 30 km, but also a high performance switching product that

enables enterprises to send local FC network information over high-speed optical, IP or ATM network clouds to remote storage facilities located anywhere in the world. Storage area networking (SAN) is a vital application to enterprise businesses today, as the exponentially-growing amount of mission-critical information needs to be transferred to remote back-up locations for storage."

SAN DIEGO, Calif. - February 28, 2000 - **Centripetal** today announced Data Services Suite™, a new breed of Internet storage utility services that will enable Web-centric companies to outsource data storage at colocation facilities on a pay-as-you-grow basis. - Today, many Web-centric companies must "co-locate" their Web servers, that is, house the servers in a shared facility with high-bandwidth Internet connectivity. Colocation enables companies to capitalize on bandwidth discounts and increased availability of mission-critical data. Many of these companies are also looking for backup and storage services in the same facility to extend the benefits of lower cost and high availability to data storage. Centripetal's Data Services Suite will allow these companies to pay a monthly fee for storage and enable them to focus on their core competencies rather than on purchasing, managing and maintaining a data storage facility. At the same time, companies can significantly lower their total cost of ownership (TCO) while improving speed, reliability, scalability and data security.

Centripetal will offer storage utility services through centralized, shared SANs at leading colocation facilities with direct Internet backbones. The company's first facility in San Diego will be fully operational in March, 2000 and will have 26 terabytes of ultra-fast SAN-based storage available for lease on a monthly basis. In addition, the company will offer storage services such as backup and disaster recovery. The company plans to have storage services on-line in 27 co-location centers by December 2000.

SINGAPORE- Feb. 25, 2000 - **Trek Technology**, a Singapore-based technology research and design solutions provider, launched its revolutionary Thumb Drive at CeBIT 2000 in Hannover, Germany, this week.. The Thumb Drive is a technological breakthrough in the memory-data companion IT sector. Measuring only 45 mm in length and 30g in weight, the Thumb Drive operates on the "plug-and-play" system using USB Version 1.0. Unlike products currently available in the retail and OEM market, the Thumb Drive does not require the use of cumbersome cables, external hardware or PCMCIA adapters -- making it truly mobile and convenient to use. It is

also device-friendly as it can be used as a memory companion for PDAs, laptops, as well as desktop PCs. The Thumb Drive has the capacity to store data ranging from 8MB to 128MB and is able to transfer data at 700 kb/sec. Independent of batteries, the Thumb Drive draws power from the PC or notebook while functioning just like an external drive.

Said Mr. Henn Tan, Chief Executive Officer of Trek 2000 International, "When we started our R&D for the Thumb Drive, we had in mind the requirements of the market, namely the need for mobility, ease of use, data safety and of course, cost. With its storage capacity, the Thumb Drive allows the user to carry large data files conveniently and quite literally in their pockets. All that is needed is to install the device into the computer by inserting it into the USB port and the computer will automatically detect its presence."

NEW YORK, Feb. 24, 2000 - **StorageTek** today announced the immediate availability of the StorageTek L180 Tape Library at the Company's annual financial analysts' meeting. - The L180 allows mid-size businesses to take advantage of the advanced information management capabilities of StorageTek tape libraries, including support for mixed media, flexible interface options, outstanding scalability, superior robotics and high-availability features. In combination with the recently announced StorageTek 9840 Fibre Channel tape drive, the L180 tape library is the industry's first SAN-ready all-native Fibre Channel automated tape solution. End-to-end Fibre Channel solutions allow distance extension and drive sharing across many UNIX and Windows NT servers, enabling businesses to manage and share data faster and more simply.

Pricing and Availability:- StorageTek's L180 Tape Library provides capacity of up to **seven terabytes** (uncompressed) and is targeted at the UNIX and Windows NT marketplaces for midrange, open systems implementations. It supports up to 10 DLT drives or six 9840 drives, or a combination of both. The L180 is immediately available worldwide through StorageTek and StorageTek channels. Pricing starts at $44,520 for an 84-slot library with standard SCSI-3 interface (drives and Fibre Channel interface are priced separately).

Sunnyvale, California, February 23, 2000 - **Amdahl Corporation** today announced that the Platinum/400 RAID storage subsystem attaches to open systems UNIX® and Windows NT® platforms, via a storage area network (SAN) environment, as well as to the System/390 platform. - Platinum/400 will connect to Sun™ Solaris™, HP-UX, and IBM AIX to allow enterprises to share the same storage platform for a diversity

ZDNet India
Reviews

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Trekstore Thumbdrive 16MB

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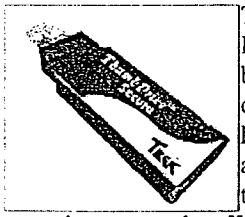

Teenie Weenie Drive

Imagine a device that uses no batteries, no software, no cables, and no external hardware required to transfer and store data. Imagine a drive that is so small that you can carry in your pocket. Welcome aboard the 16MB Trek Thumbdrive. Claiming to be the world's smallest drive it uses USB plug and play connectivity showing up just like any drive in windows explorer making it all the more portable. With the specified transfer rates of 700Kbytes/sec and 350Kbytes/sec for read and write respectively it makes this drive an excellent tool for fast transfers of small files.

We tested the drive by doing both the real world transfer test and the SiSoft Sandra drive test. In the real

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- Windows XP

Editor's Pick

- Trekstore Thumbdrive 16MB
- Roll down to Rio with SONICblue
- ATI Technologies Radeon 32MB DDR
- Getting into the Groove

- Transmeta to keep 'em coming
- HP: First laptop with Athlon chip coming

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- Software
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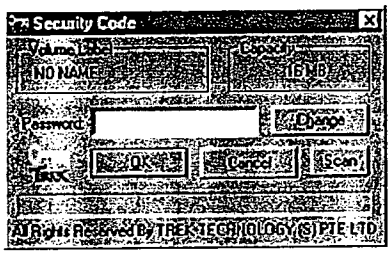
world test we found 3 test files totaling up to 15MB taking 56 seconds to copy, wherein a single 15MB file transfer taking about 42 seconds. SiSoft Sandra turned up with some very unbelievable scores, churning out a drive index of 91756, which is without doubt the highest ever seen. The score was high due to the simple reason that the drive has no moving parts involved and uses flash RAM technology. Lastly the thumbdrive also incorporates a write protection switch that can be used to secure data against accidental erasure of data.

The Thumbdrive is also available in 32MB, 64MB, 128MB and 256MB capacities.

Looking for something secure? Trekstore offers their **Thumbdrive Secure** which requires the user to enter a password before he/she is granted access to the content stored on the drive.



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Related Links:

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Trekstore Thumbdrive 16MB

A closer look

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Specifications
16MB THUMBDRIVE
USB SPEC 1.1 Compliant
30gram weight
Supports Windows 98/ME

Pros
+ Small and easy to use
+ Low power consumptions and no external power supply required

Cons
- Cost per Megabyte is high

Verdict: B+
Performance: 4
Build Quality: 4
Value for money: 3

Specials

- Digital Cameras
- ISP Finder
- Mobile Supercentre
- Motherboard Supercentre
- Office XP
- Windows XP

Editor's Pick

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Features: 4
Overall: 4

Contact: Sparrow Electronics Limited
Address:
344, Raheja Arcade
1/1, Koramangla Industrial Area
Bangalore - 560095
Phone: 080 553 1568
Fax: 080 553 1874
E-mail: qsales@sparrowit.com
Homepage: http://www.sparrowit.com/
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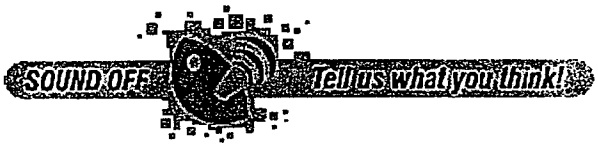

Dell Drops Floppy Drives in New PCs

Future Dimension 8250 desktops will offer floppy drives as an option--alongside thumb drives.

Tom Mainelli, PCWorld.com
Wednesday, February 05, 2003

It's time to say goodbye to the floppy drive.

We've all heard that before, but this time Dell means it. The company will stop listing the floppy drive as a default entry on its top-end consumer desktop, the Dimension 8250, starting later in February. To get one, you'll have to ask for it.

"We want to introduce them [customers] to the alternatives and let them choose," says Shannon Baxley, manager for Dimension product marketing. Dell thinks that most customers, forced to choose, will go with something more useful--specifically, thumb drives.

Alongside its floppy drive option, the company plans to offer at least two Dell-branded thumb drives, including one carrying the same price as a floppy drive. Thumb drives plug into a standard USB port, use flash memory, offer faster transfer speeds, and have greater capacity than a floppy disk.

Dell hasn't set the pricing on its floppy drive option yet, and Baxley won't estimate late-February pricing for the company's 16MB or 64MB thumb drives. Currently Dell sells the 16MB thumb drive for $17 and the 64MB model for $30.

Evolution in Action

The floppy drive has been functionally obsolete for some time; most of the files people share are simply too large to fit on its meager 1.44MB capacity.

"Most people can't recall the last time they used their floppy. Customers were telling us they don't use it," says John New, senior manager for Dimension product planning. Most people are, however, afraid not to have one. "It's mostly just a comfort factor, he says. "They think, 'I might need it.'"

Once customers understand that there are better options--from thumb drives to CD-RW drives--the lack of a floppy drive will cease to be an issue, he says.

In the meantime, floppy drives are optional only on Dell's Dimension 8250--it remains standard on other systems. But Dell will extend the policy across its line as acceptance grows.

Dell representatives say that the company is cutting floppies first from its top-of-the-line Dimension 8250 because that's the PC the most-experienced PC users buy. "Tech-savvy people are of the opinion that this is five years overdue," New says.

Following Apple's Lead

Apple dropped the floppy from the systems in its product lineup nearly five years ago. It was a bold move that--over the years--relatively few PC vendors have tried to emulate.

Most floppy-less PCs, however, weren't successful. Evidently, PC buyers weren't quite ready to say goodbye.

Now, Dell is prepared to usher the technology out the door for good.

"Somebody with the influence of a Dell or other tier-one participant has to take the first step," New says. "We felt it was time to do that." And this time, the company doesn't expect much resistance, he says.

"We don't expect this to be an issue," New says. "When you give the customer the flexibility to choose, they'll be happy."

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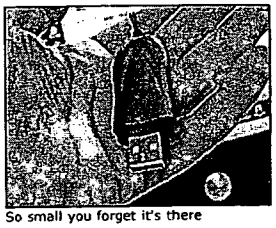
The rise of the keyring drive

By Dominic Casciani
BBC News Online

The floppy disk is dead. Long live the pocket drive, a tiny piece of kit that is a revolution.


So small you forget it's there

There's a lot of guff about the unstoppable march of technology - not least from the people who want us to buy it.

But sometimes a gadget comes along that genuinely changes the way you think about what you can do. The sudden appearance of tiny keyring drives may turn out to be one such development.

The floppy drive effectively whirred out its last bytes this year when PC manufacturer Dell followed an earlier decision from Apple to stop putting them in new machines.

Floppies became redundant because they were surpassed by e-mail and removable storage such as CDs and external hard drives. But e-mail is unsuitable unless you are one of the lucky few with broadband, and removable drives are expensive and can be a pain to set up.

So what happens when you need an easy way of transferring files between work, home, and friends and family? The answer, it appears, is stick a drive on a key ring.

Portability is key

I wanted a small and portable way of quickly transferring pictures, documents and MP3s between an old PC, an iMac and a work laptop.

My PC was so clunky it didn't have a CD writer. E-mailing files from one to the other would have been agony on my 56k home line.

Then a friend told me about keyring drives. For less than £20, I got 16mb of storage -

FLOPPY DISKS

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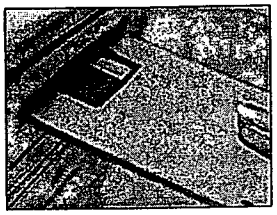
about 11 floppy disks' worth - inside a plastic shell little bigger than a pen top.

"Just stick it in the computer, sir, and then transfer the files," said the shop assistant. "What - no delving into systems or help-lines when it crashes?" "Yep, that's it. It will just work as stated."



Emerged in 1970s
Slowly became obsolete because of small capacity
First ditched by Apple, 1998
Ditched by Dell, 2003
Mostly replaced by cumbersome CD burning

R.I.P. Floppy disks

And he was right. I inserted it into the iMac and it popped up as an extra drive on the desktop. I dragged and dropped a file on to it. No crash yet.

I pulled out the pocket drive and stuck it in my work laptop. It appeared again. And within seconds the document was on the second computer. Wow. While my partner was under-whelmed, this event was a revolution to an apprentice geek like me.

This was a storage device that you happily plug in and pull out of any system and it will transfer files without fuss.

Compatibility and price

What makes this so different is the manufacturers have cracked the two things most home computer users most complain about: compatibility and price.

These pocket drives (with various brand names) use a USB port and flash memory. USB allows two separate pieces of hardware, such as a laptop and a printer, to talk to each other through a universally-recognised connection.

Flash memory is the technology which allows hardware such as digital cameras to store pictures when the power is turned off. It has no moving parts and is effectively indestructible.

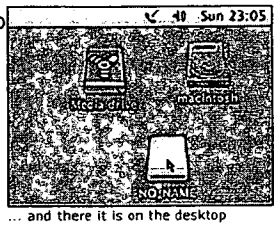
Just plug it into a USB port...

The largest capacity (and most expensive) keyring drive on the market stores a whopping one gigabyte of data - the equivalent of more than 700 standard floppy disks. Providing it is used correctly, the chances of losing data on keyring drive are slim to none.

But, crucially, prices have been coming down as more and more drives come onto the market. For less than £100, a home user can finally get more than enough capacity plus the ability to protect the content from being overwritten. So is this just a glorified floppy disk? No, it's much more.

Firstly, these pocket drives are generally large enough to store MP3s so you don't need to individually back-up each CD on each computer where you listen to it.

Similarly, the friend who recommended the drive has used it to make a small multi-media business presentation, rather than burn a CD for a 15-minute meeting.



... and there it is on the desktop

Secondly, programs can be run from the drive just as they would be from any hard disk.

I tried this at the weekend with a program which does a security check on your PC to properly delete files you don't want others to see, such as cookies and virtual paper trails left by online banking.

This potentially is a headache for systems people as it brings a whole new meaning to the idea of hacking or breaching secure systems and getting away with it.

Finally, the relatively small cost of flash memory has the potential to completely change the dynamics of other businesses.

Why invest millions in sending movies down broadband cables when, theoretically, you could whack a tiny and cheap keyring drive into a DVD player? For home users, why go to the hassle of burning files on to CDs (unless you are giving away copies) when you can just slap them on a keyring?

Both of these are some way off yet. For me right now I just like the way I can keep the keyring drive in my bag and not even know it's there. Finally, technology that makes life easier.

Send us your comments:

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I have a 64mb memory stick and in only a couple of months it has saved my life twice by allowing me to swap files between computers. It's also a lot quicker than using the old bulky Zip drives. A marketing friend also picked up the idea of using them for business presentations. Presumably they should catch on as promotional business gifts if they can be branded and re-used.
Simon Bennett, UK

The keyring is a great idea for carrying files like presentations, music, project folders and I'd like to see how they work in practice with a large cohort of students that I teach. I thought Apple were right to ditch floppy drives five years ago and it's odd how quickly things have moved on.
Jonathan, United Kingdom

I'm still happy to use floppy disks. CD burning also does for me - it's hardly cumbersome. Finally, for a CD or floppy disk, I don't have to go under my desk and root around the back of my PC. And believe it or not people do have devices that don't have USB.
Tony, UK

My pocket drive has revolutionised the way I take files between home and work. One of the best things about it is that it works on PC or Mac. The only thing that slows me down is plugging it into my PC as I have to grovel around in the dark under my desk to locate the USB port. Suddenly the USB ports on the Mac keyboard make sense.
Ben Hanke, England

It sounds like hackers would be able to use them to by pass company firewalls by inserting a virus on a employee's PC at home and get them to bring the virus in past the expensive

THE REGISTRY OF PATENTS
SINGAPORE

THE PATENTS ACT
(CHAPTER 221)

CERTIFICATE OF GRANT OF PATENT

In accordance with section 35 of the Patents Act, it is hereby certified that a patent having the following P-No. 87504 [WO 01/61692] had been granted in respect of an invention having the following particulars:

Title	:	A PORTABLE DATA STORAGE DEVICE
Application No.	:	200201280-5
Date of Filing	:	21 February 2000
Priority Data	:	-
Name of Inventor(s)	:	CHENG, CHONG, SENG
Name(s) and Address(es) of Proprietor(s) of Patent	:	TREK TECHNOLOGY (SINGAPORE) PTE LTD 30 LOYANG WAY #07-13/14/15 LOYANG INDUSTRIAL ESTATE SINGAPORE 508769
Date of Grant	:	16 April 2002

Dated this 16th day of April 2002.

Liew Woon Yin (Ms)
Registrar of Patents,
Singapore.

A Portable Data Storage Device

The invention relates to a portable data storage device, and in particular, a portable data storage device for a computer.

Conventional data storage devices generally fall into two categories. The first category is electronic, solid-state memory devices such as read only memory (ROM) and random access memory (RAM). These memory devices are generally fitted within the computer. They are not intended to be removable or portable so that they may be used on different computers, for example, to permit the transfer of data from one computer to another computer.

The second type of device is surface based data storage devices in which data is stored, typically, on the surface of a disk or tape. Examples of surface storage devices are magnetic disks and CD ROMs. Such data storage devices require a mechanical drive mechanism to be installed in or coupled to the computer to permit the data on the storage device to be read by the computer. In addition, such memory devices are limited by the surface area of the storage device, and the combination of the storage device and the drive mechanism for reading data from the storage device is generally bulky and/or delicate due to the moving parts that are required within the drive mechanism and/or storage device.

In accordance with the present invention, there is provided a portable data storage device comprising a coupling device for coupling to a computer serial

bus, an interface device coupled to the coupling device, a memory control device and a non-volatile solid-state memory device; the memory control device being coupled between the interface device and the memory device to control the flow of data from the memory device to the coupling device.

An advantage of the invention is that by providing a portable data storage device comprising a coupling device with an interface device, memory control device and a non-volatile solid-state memory device, it is possible to provide a portable data storage device which may be coupled to a computer having a serial bus port and which does not include moving parts or require a mechanical drive mechanism to read the data from the data storage device.

Preferably, the non-volatile solid-state memory device may be a read/write memory device, such as a flash memory device.

Preferably, where the memory device is a read/write memory device, the memory control device controls the flow of data to and from the memory device.

Typically, the data storage device further comprises a manually operated switch movable between a first position in which writing of data to the memory device is enabled, and a second position in which writing of data to the memory device is prevented.

Preferably, the memory control device may include a read only memory which stores a program to control the operation of the memory control device. Preferably, the memory control device is a micro-controller.

Typically, the interface device comprises a universal serial bus (USB) driver to convert data between a USB format and a PC format, and the coupling device comprises a USB coupling deivce.

Alternatively, the interface device comprises a driver for IEEE 1394 (Firewire) protocol, and the coupling device comprises a Firewire coupling device.

An example of a data storage device in accordance with the invention will now be described to the accompanying drawings, in which:

Figure 1 is a schematic block diagram of a portable data storage device;

Figure 2 is a flow diagram showing the initial setup of the data storage device by a software supplier;

Figure 3 is a flow diagram showing the initial setup of the data storage device by an end user; and

Figure 4 is a flow diagram showing operation of the data storage device.

Figure 1 shows a data storage device 10 which includes a USB plug 1 which is coupled to a USB interface device 2. The USB interface device 2 is coupled to a micro-controller 3 which is coupled to a flash memory 4. The micro-controller

3 includes a read only memory (ROM) 5 which stores a program to control the operation of the micro-controller 3.

The operations performed by the micro-controller 3 include comparing passwords entered by a user with a corresponding password stored in the flash memory 4 to determine whether the user is authorised to access the contents of the flash memory 4. The program stored in the ROM 5 also controls the data flow to and from the flash memory 4 and can also detect whether the computer to which the memory device 1 is coupled has installed software programs which correspond to passwords stored in the flash memory 4. The micro-controller 3 can automatically retrieve passwords from the installed software to compare with passwords stored in the flash memory to verify that a user of the computer is authorised to access and run the software. In addition, the program stored in the ROM 5 also permits the setting of a password in the flash memory by a software supplier to correspond to the password contained in software supplied to a user. Typically, the password may correspond to the serial number of the software.

The flash memory 4 is typically divided into a number of different sections or zones. Typically, the flash memory is divided into two zones and each zone has a unique password. If the data storage device 10 is supplied with packaged software, the software serial number can be set in one zone to be the password to permit a user to access and use the software. The other zone, which can be used typically for storing a user's data, may have a separate password which is set by the user. Typically, the passwords are stored in a secure location of the

flash memory in an encrypted form. The encryption, decryption, data flow control and USB protocol are all managed by the micro-controller 3.

The micro-controller 3 also includes a random access memory (RAM) 6 which is a temporary storage area to permit functioning of the micro-controller 3. In addition, a manual switch 7 is coupled between the flash memory 4 and the micro-controller 3. The manual switch 7 is movable between a first position in which a user may write data to the flash memory 4 and a second position in which data is prevented from being written to the flash memory 4.

The device 10 also includes a USB socket 8 that is coupled directly to the USB plug 1 and permits other USB devices to be coupled to the USB via the device 10. For example, if a user wishes to increase memory space, a USB plug 1 of a second memory device 10 may be connected to the USB socket 8.

Figure 2 is a flow diagram showing the set up procedure for the device 10 for a software supplier when the software supplier intends to supply the device as an authentication device for the software. Firstly, the plug 1 of the device 10 is plugged into 20 to a USB socket on a computer. After the device 10 has been plugged into the USB socket on the computer, a communication is established 21 between the computer and the device 10. The software supplier has pre-installed installation software on the computer which is run by the operator. From the pre-installed software, the operator selects password set up installation 22, in response to which the pre-installed software requests the operator to enter a password or serial number corresponding to the software

with which the device 10 is to be supplied. The password or serial number is then encrypted 26 and stored 27 in the flash memory 4.

Figure 3 is a flow diagram showing the initial set-up of a password for zone 2 of the flash memory 4 by an end user. The device 10 is typically supplied with driver software that is loaded by the user onto the computer prior to set-up of the device. To set-up the password for zone 2 the user plugs in 20 the device 10 into a USB port on the computer and communication 21 is established between the computer and the device 10. The user then runs the driver software and the driver software enters a password installation set-up mode 23 for zone 2. The user then enters 28 a password that they wish to use to prevent unauthorised access to zone 2 of the flash memory 4. The password entered is then encrypted 29 and stored 30 in the flash memory 4.

After an end user has performed the initial password set up procedure described above and shown in Figure 3, when a user plugs in 20 the device 10 to a USB port on a computer, the computer will establish a communication 21 with the device 10 and firstly, checks 33 an installation status flag stored in the flash memory 4 (see Figure 4). If the status flag is "Y", the device 10 outputs 34 an "OK" flag to the computer. The micro-controller 3 the instructs the computer to issue a request 35 to the user to select the zone they wish to enter. If the status flag is "N", the device does not output an "OK" flag to the computer, and goes straight to step 35. In response to the request 35 for zone selection, the user selects 36 either zone 1 or zone 2.

If zone 1 is selected, the device 10 assumes that the user wishes to install software on the computer which is stored in the flash memory 4 and requests 37 the appropriate password for confirmation that the user is authorised to install the software. The micro-controller 3 receives the password entered by the user, retrieves the zone 1 password stored in the flash memory 4, decrypts the zone 1 password and compares it with the password entered by the user to authenticate 38 whether the user is authorised to install the software. If the passwords do not match, the device 10 prompts the computer to request 37 the user to enter the password again.

If the password entered by the user matches the password stored in the flash memory 4, the micro-controller 3 starts 39 the software installation from the flash memory 4 to the computer. In order to install software, the computer sends 40 a read/write command in USB format to the micro-controller 3 for data, the micro-controller 3 retrieves the requested data from the flash memory 4 and sends 41 the data to the driver 2. The driver 2 converts 42 the data to PC format and outputs the data to the computer through the USB plug 1. The micro-controller 3 then checks 43 whether the software installation is complete. If the operation is not complete, the operation returns to step 40. If the installation of the software is complete, the status flag stored in the flash memory 4 is changed to "Y" and the device 10 may then be removed 45 from the USB socket on the computer.

If a user selects zone 2, the micro-controller 3 sends a command to the computer to request 46 the user to enter the password for zone 2. When the

user enters the password, the computer sends the password to the micro-controller 3. The micro-controller 3 retrieves the password for zone 2 from the flash memory 4, decrypts 47 the password and compares it with the password entered by the user. If the password entered by the user is incorrect, the operation returns to step 46 and the computer requests 46 the user for the password again.

If the password entered by the user is correct, the user has access to zone 2 of the flash memory 4 to read data from the flash memory 4 and to write data to the flash memory 4. However, data can only be written to the flash memory 4 if the manual switch 7 is in the position to permit data to be written to the flash memory 4. In order to read or write data from or to the flash memory 4 a read or write command is sent 48 by the computer in USB format to the micro-controller 3. In response to the read or write command the micro-controller 3 either retrieves 49 data from the flash memory 4 and sends it to the driver 2 for conversion 50 to PC format and then to be output to the computer or receives data from the driver to write it to the flash memory 4.

The micro-controller 3 then determines 51 whether the read or write operation is complete. If the operation is not complete it returns to step 48. If the operation is complete the operation terminates 52.

The device 10 described above is for coupling to a universal serial bus (USB). However, the plug 1, the interface device 2 and socket 8 could be for use with any appropriate computer serial bus. For example, the device 10 could be

modified for use with IEEE 1394 (Firewire) protocol by substituting the USB plug 1, USB interface device 2 and socket 8 with a Firewire protocol compatible plug, interface device and socket respectively.

An advantage of the device 10 described above is that it provides a portable data storage device for a computer which does not require a mechanical operated reading/writing device. In addition, the device 10 has no moving parts. This enables to data storage device 10 to be more compact than conventional portable data storage devices.

CLAIMS

1. A portable data storage device comprising a coupling device for coupling to a computer serial bus, an interface device coupled to the coupling device, a memory control device and a non-volatile solid-state memory device; the memory control device being coupled between the interface device and the memory device to control the flow of data from the memory device to the coupling device.

2. A device according to claim 1, wherein the non-volatile solid-state memory device is a read/write memory device.

3. A device according to claim 2, wherein the read/write memory device is a flash memory device.

4. A device according to claim 2 or claim 3, wherein the memory control device controls the flow of data to and from the memory device.

5. A device according to any of claims 2 to 4, further comprising a manually operated switch movable between a first position in which writing of data to the memory device is enabled, and a second position in which writing of data to the memory device is prevented.

6. A device according to any of the preceding claims, wherein the memory control device comprises a micro-controller.

7. A device according to any of the preceding claims, wherein the coupling device comprises a universal serial bus coupling device and the interface device comprises a USB driver.

8. A device according to any of the preceding claims, wherein the coupling device comprises an IEEE 1394 (Firewire) protocol coupling device and the interface device is a Firewire protocol driver.

ABSTRACT

A Portable Data Storage Device

A portable data storage device (10) includes a universal serial bus (USB) coupling device (1) and an interface device (2) is coupled to the USB coupling device (1). The portable data storage device (10) also includes a memory control device (3) and a non-volatile solid-state memory device (4). The memory control device (3) is coupled between the interface device (2) and the memory device (4) to control the flow of data from the memory device (4) to the USB coupling device (1).

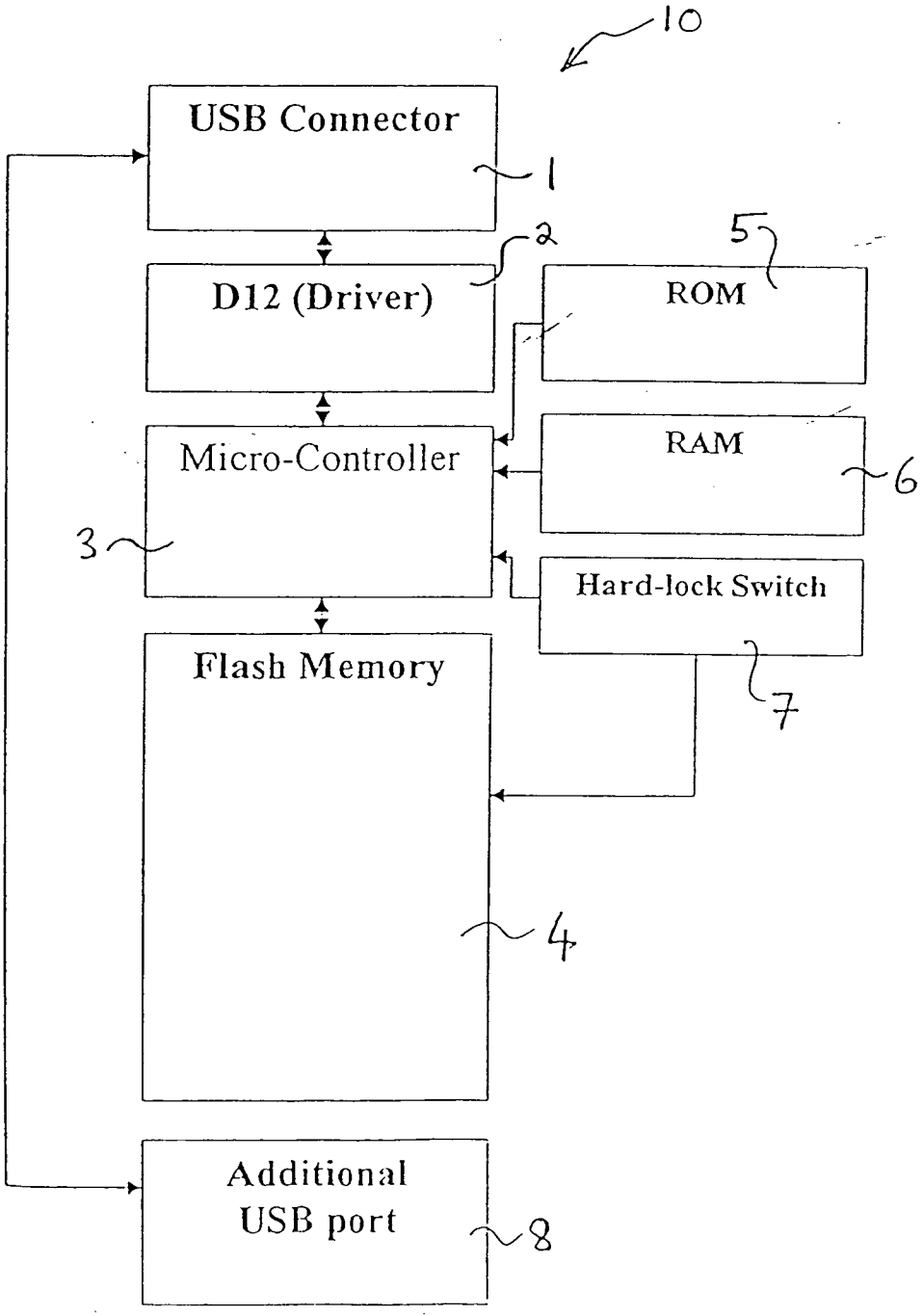

10
USB Connector
1
2
D12 (Driver)
5
ROM
Micro-Controller
RAM
6
3
Hard-lock Switch
7
Flash Memory
4
Additional
USB port
8

Figure 1

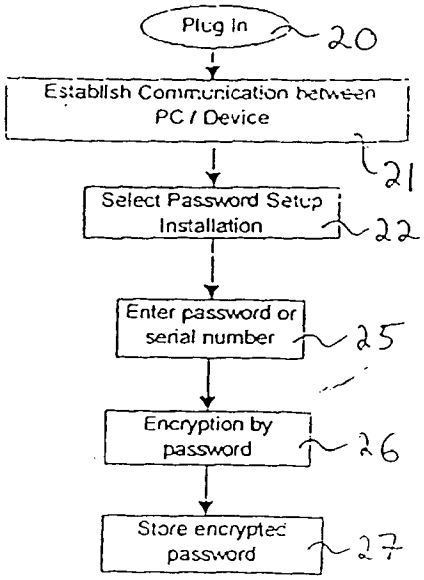


Figure 2

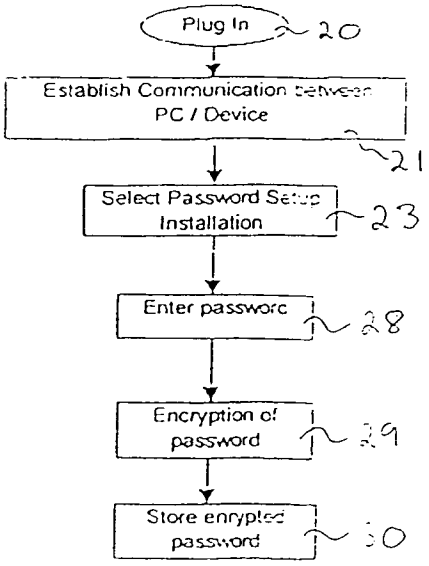


Figure 3

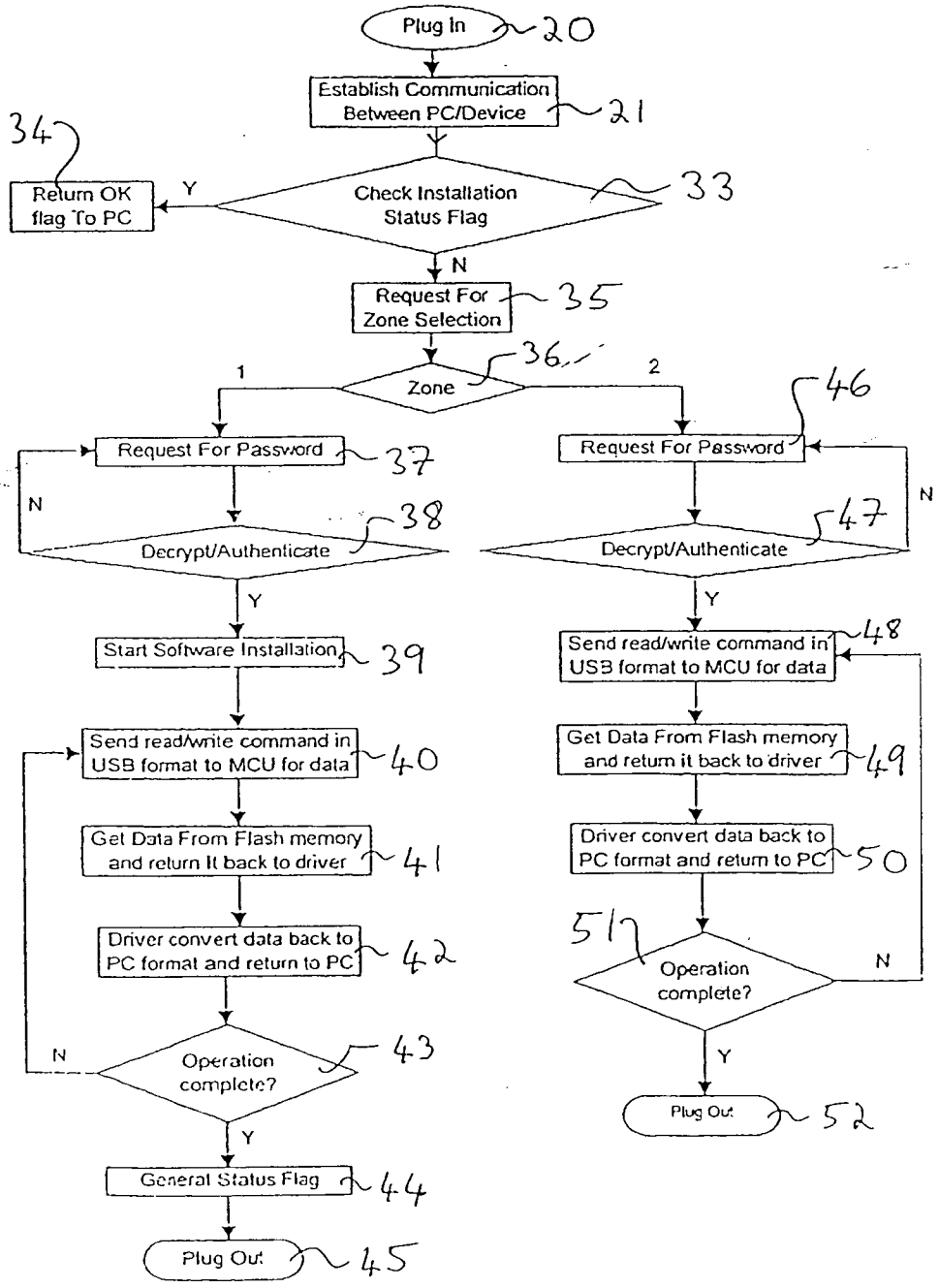

Plug In
20
Establish Communication Between PC/Device
21
34
Return OK flag To PC
Y
Check Installation Status Flag
33
N
Request For Zone Selection
35
Zone
36
1
2
Request For Password
37
N
Decrypt/Authenticate
38
Y
Start Software Installation
39
Send read/write command in USB format to MCU for data
40
Get Data From Flash memory and return it back to driver
41
Driver convert data back to PC format and return to PC
42
N
Operation complete?
43
Y
General Status Flag
44
Plug Out
45
46
Request For Password
N
47
Decrypt/Authenticate
Y
48
Send read/write command in USB format to MCU for data
Get Data From Flash memory and return it back to driver
49
Driver convert data back to PC format and return to PC
50
51
Operation complete?
N
Y
Plug Out
52

Figure 4

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/SG 00/00029

73

Patent document cited in search report			Publication date	Patent family member(s)			Publication date
US	A	5760986	0::-06-1998	EP	A1	614564	14-09-1994
				EP	A4	614564	19-07-1995
				US	A	5379171	03-01-1995
				WO	A1	9306594	01-04-1993
				US	A	5835303	10-11-1998
				US	A	5579189	26-11-1996
				US	A	5592349	07-01-1997
				US	A	5694267	02-12-1997
				US	A	5867340	02-02-1999
US	A	6016530	18-01-2000	US	A	5778418	07-07-1998
US	A	6058441	02-05-2000	none			

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SG 00/00029

74

CLASSIFICATION OF SUBJECT MATTER

IPC[7]: G11B 11/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC[7]: G11B 11/00, 02,05

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

G06F 3/00, 12/00, 12/06

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6016530 A (AUCLAIR et al.) 18 January 2000 (18.01.00)	1
P,A	US 6058441 A (SHU) 2 May 2000 (02.05.00)	1
A	US 5760986 A (MOREHOUSE et al.) 2 June 1998 (02.06.98)	1

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
„A" document defining the general state of the art which is not considered to be of particular relevance
„E" earlier application or patent but published on or after the international filing date
„L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
„O" document referring to an oral disclosure, use, exhibition or other means
„P" document published prior to the international filing date but later than the priority date claimed
„T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
„X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
„Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
„&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
24 March 2001 (24.03.2001)	12 April 2001 (12.04.2001)
Name and mailing address of the ISA/AT Austrian Patent Office Kohlmarkt 8-10, A-1014 Vienna Facsimile No. 1/53424/535	Authorized officer GRÖSSING Telephone No. 1/53424/386

Form PCT/ISA/210 (second sheet) (July 1998)

IN THE HIGH COURT OF THE REPUBLIC OF SINGAPORE

[2005] SGHC 90

Suit No 609 of 2002/N

Between

TREK TECHNOLOGY (SINGAPORE) PTE LTD
(RC No. 198902818Z)

Plaintiff

And

1. **F E GLOBAL ELECTRONICS PTE LTD**
(RC No. 199001577W)
2. **ELECTEC PTE LTD** (RC No. 199001525M)
3. **M-SYSTEMS FLASH DISK PIONEERS LTD**
(ISRAEL RC No. 52-003884-5)

Defendants

Suit No 604 of 2002/N

Between

M-SYSTEMS FLASH DISK PIONEERS LTD
(ISRAEL RC No. 52-003884-5)

Plaintiff

And

TREK TECHNOLOGY (SINGAPORE) PTE LTD
(RC No. 198902818Z)

Defendant

Suit No 672 of 2002/S

Between

TREK TECHNOLOGY (SINGAPORE) PTE LTD
(RC No. 198902818Z)

Plaintiff

And

RITRONICS COMPONENTS (S'PORE) PTE LTD
(RC No. 198600333N)

Defendant

JUDGMENT

Trek Technology (Singapore) Pte Ltd
v
FE Global Electronics Pte Ltd and others and other suits

[2005] SGHC 90

High Court — Suits Nos 609, 604 and 672 of 2002
Lai Kew Chai J
12–30 April; 4–5 May 2004; 10 November 2004; 3 May 2005

12 May 2005 *Judgment reserved.*

Lai Kew Chai J:

Trek

1 Trek Technology (Singapore) Pte Ltd ("Trek") filed two actions (Suits Nos 609 and 672 of 2002) against the following defendants:

(a) FE Global Electronics Pte Ltd ("FE Global");

(b) Electec Pte Ltd ("Electec");

(c) M-Systems Flash Disk Pioneers Ltd ("M-Systems"); and

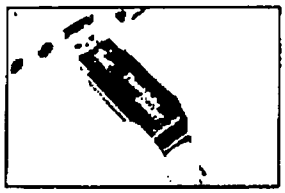
(d) Ritronics Components (S'pore) Pte Ltd ("Ritronics").

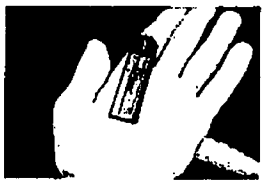
M-Systems manufactures and sells a portable data storage device that is marketed as "DiskOnKey" ("DOK") and "Diskey" ("Diskey"). Electec is the exclusive Singapore importer of Diskey. FE Global is the exclusive Singapore distributor of Diskey. Ritronics manufactures and sells the storage devices known as "SlimDisk" ("SD") and "BioSlimDisk" ("BSD"). Another action was commenced by M-Systems against Trek for threatened patent infringement (Suit

No 604 of 2002). All three actions were consolidated and heard together. The crux of the actions concerned various infringing acts alleged to have been committed by the defendants in relation to Trek's patent No 87504 (WO 01/61692) in Singapore ("the Patent") in respect of Trek's data storage device known as "ThumbDrive" ("ThumbDrive"). In what has become the common response of defendants to infringement proceedings, the defendants challenged the validity of Trek's patents and cited prior art to substantiate the alleged lack of novelty and inventiveness. The defendants also alleged that Trek had made material misrepresentations to the registrar of patents over the issues of inventorship and ownership.

Trek's storage technology

2 Trek invented a portable mass storage device designed to be as portable and compact as the conventional floppy or CD-ROM storage media. Trek's storage device boasted a capacity that far exceeded that of other mass storage devices. The following are reproduced images of the ThumbDrive:





3 The ThumbDrive can be inserted into any universal serial bus ("USB") socket, and become fully integrated with another device, typically a personal computer ("PC"). It offers users the advantages of universality (achieved by the integration of a USB plug for direct connection into any corresponding socket of a PC); compactness (a small convenient form factor); portability (no additional power supply is needed, resulting in greater mobility), ease of use (it is "hot-

swappable"; *ie* a user can freely insert or remove the ThumbDrive without first having to turn the PC off); and cost-effectiveness (it is affordable).

4 Experts have testified that the ThumbDrive was an exceptional and distinctively new solution over existing conventional data storage devices. They are also impressed by the ThumbDrive's unique implementation and how elegant the solution is. The ThumbDrive is a casual appendage to a PC, and differs from other devices in that it is not permanently mounted inside a PC, or inserted into a "special purpose" slot like the PCMCIA slot for interaction with the machine. The conspicuous absence of an intervening cable also sets the ThumbDrive apart from other storage devices. Trek also drew my attention to positive responses from the industry, where the ThumbDrive has been heralded as, *inter alia*, a "groundbreaking product". It has also been said that this storage solution marked the "beginning of the end" of floppy drives (see <www.techwarelabs.com>).

The Patent

5 Trek filed an application on 21 February 2002 to register a patent in Singapore for its ThumbDrive. A week later, the ThumbDrive was launched at the CeBIT 2000 exhibition in Germany. Subsequent applications have been filed in over 30 countries. Patents have been granted in the UK, New Zealand and South Africa.

6 I now turn to the patent specifications.

Patent specifications

7 Section 113(1) of the Patents Act (Cap 221, 2002 Rev Ed) is the starting point. It states:

> For the purposes of this Act, an invention for a patent for which an application has been made or for which a patent has been granted shall, unless the context otherwise requires, be taken to be that specified in a claim of the specification of the application or patent, as the case may be, as interpretated by the description and any drawings contained in that specification, and the extent of the protection conferred by a patent or application for a patent shall be determined accordingly.

8 In establishing the parameters of the Patent, under s 113 the court is confined to an interpretation within the "ringfence" of the claim of the specification of the Patent, with reference to the description and any drawings within the specification.

9 The Patent relates to a portable data storage device for a computer. The description of the state of the art in the field is set out in the Patent as follows:

> Conventional data storage devices generally fall into two categories. The first category is electronic, solid-state memory devices such as read only memory (ROM) and random access memory (RAM). These memory devices are generally fitted within the computer. They are not intended to be removable or portable so that they may be used on different computers, for example, to permit the transfer of data from one computer to another computer.
>
> The second type of device is surface based data storage devices in which data is stored, typically, on the surface of a disk or tape. Examples of surface storage devices are magnetic disks and CD-ROMs. Such data storage devices require a mechanical drive mechanism to be installed in or coupled to the computer to permit the data on the storage device to be read by the computer. In addition, such memory devices are limited by the surface area of the storage device, and the combination of the storage device and the drive mechanism for reading data from the storage device is generally bulky and/or delicate due to the moving parts that are required within the drive mechanism and/or storage device.

10 The Patent (in pp 1–2) describes the elements that comprise the invention as follows:

> In accordance with the present invention, there is provided a portable data storage device comprising a coupling device for coupling to a computer serial bus, an interface device coupled to the coupling device, a memory control device and a non-volatile solid-state memory device; the memory control device being coupled between the interface device and the memory device to control the flow of data from the memory device to the coupling device.
>
> An advantage of the invention is that providing a portable data storage device comprising a coupling device with an interface device, memory control device and a non-volatile solid-state memory device, it is possible to provide a portable data storage device which may be coupled to a computer having a serial bus port and which does not include moving parts or require a mechanical drive mechanism to read the data from the data storage device.

11 The Patent makes many references to the device being plugged into the computer's USB port. For example:

> Figure 1 shows a data storage device 10 which includes a USB plug 1 which is coupled to a USB interface device 2.
>
> ...
>
> The device 10 described above is for coupling to a universal serial bus (USB). However, the plug 1, the interface device 2 and socket 8 could be for use with any appropriate computer serial bus. For example, the device 10 could be modified for use with IEEE 1394 (Firewire) protocol by substituting the USB plug 1, USB interface device 2 and socket 8 with a Firewire protocol compatible plug, interface device and socket respectively.
>
> An advantage of the device 10 described above is that it provides a portable data storage device for a computer which does not require a mechanical operated reading/writing device. In addition, the device 10 has no moving parts. This enables [the] data storage device 20 to be more compact than conventional portable data storage devices.

12 Figure 1 of the Patent, which is reproduced below, shows a block diagram of the portable data storage device. The actual components have been placed against each corresponding element described in the specifications and which have been shown in an assembled form (numbered as "10" in the diagram).

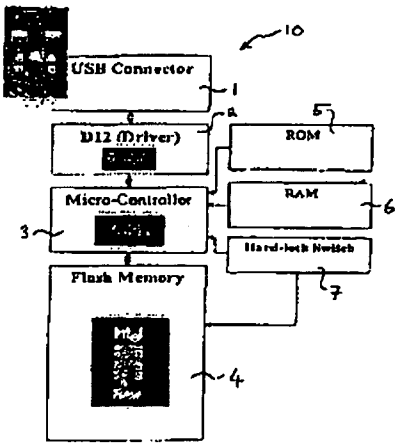


Figure 1

13 The above descriptions and specifications should inform the skilled addressee of the workings of a portable mass storage device with an integrated plug for direct connections to the USB socket of a PC, without the need for an intervening cable. The ThumbDrive sits as a compact, portable and easily accessible appendage to the PC.

14 On a purposive construction, claim 1 of the Patent discloses a portable data storage device *without* any cable. It has an integrated USB plug. Trek's expert, John Hyde, prepared a video presentation which assisted the court in understanding the Patent. It was helpful. According to Mr Hyde, the skilled addressee will understand the Patent to disclose the following:

> [A] portable memory device having an integrated USB plug for directly connecting to the USB socket on a computer without an intervening cable. No mention is made anywhere of a connecting cable. To the contrary, the ThumbDrive patent highlights the portability, compactness and durability of the device. Each component of the invention and how each relates to one another, have been clearly disclosed.

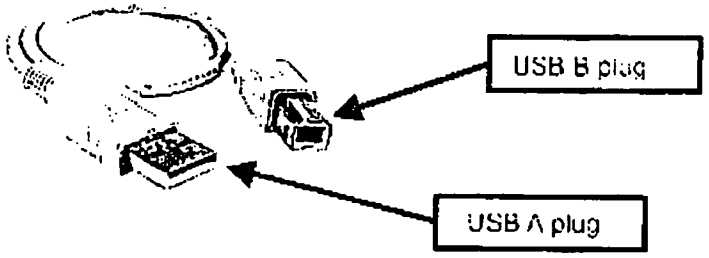
15 Another expert, Prof Kim, opined that the Patent disclosed a small, compact device with an integrated USB "A" plug.

16 The defendants offered a different interpretation of what the Patent disclosed. Their expert, Mr Shimon Shmueli, accepted that the Patent discloses a storage device that has a USB coupling and driver. However he disagreed that the coupling device in the Patent was in the form of an integrated USB "A" plug without any intervening cable. His reasoning was that since USB specifications speak of only two types of connections (captive and detachable cables), the Patent must be assumed to disclose either a captive or detachable cable.

17 I agree with Trek's interpretation that the argument for a captive cable is not supported. Nothing in the Patent could suggest to a skilled addressee the possible inclusion of and need for a captive cable. The D12 driver, identified (and numbered "2") in fig 1 above ("Philips D12 driver"), is shown in Philips' literature to be connected to a USB "B" socket, hence showing the need for a USB socket rather than a captive-cable (attached to the device). Even on a literal reading, there is no mention in the Patent that the device 10 includes a captive cable-connection between the USB plug 1 and the Philips D12 driver. A skilled addressee is unlikely to construe the Patent as disclosing a captive cable when no specific reference is made to it in the text of the Patent. By contrast the prior art patents cited by the defendants all contain direct references to cables.

18 The remaining alternative, which is the disclosure of a detachable cable, is also not supported. The court is asked to hypothesise that the portable data storage device disclosed on the Patent requires the use of an undisclosed, detachable cable which has a USB coupling device at each end. One end has a

USB "A" plug, while the other has a USB "B" plug (which will need to be connected to a corresponding socket on the device). This is illustrated as follows:



USB "A" and "B" plugs – Cable with two USB coupling devices

19 To sustain this interpretation, the skilled addressee will have to interpret the specifications to disclose the need for (a) a USB cable; (b) the cable having different USB plugs at the two ends; and (c) the presence of a USB "B" socket on the device. I am unable to accept this interpretation. First, there is no reference to any form of cable in the Patent, much less a cable with two plugs. Second, the connector on the device is expressly identified to be a USB plug rather than any other connector. No reference is made to a USB "B" socket.

20 As far as the claims of the Patent are concerned, I am of the view that the skilled addressee would take the view that the Patent discloses a unitary data storage device with an integrated USB plug to enable direct connection to the USB points of computers. Having considered the evidence in its entirety, I am unable to agree with the defendants' suggestion that a skilled addressee would have read into the claims any requirement (whether explicit or implicit) for a cable. I was also referred to instances in the prior art where the requirement of a USB cable was explicitly stated. Equally, if not more, implausible is the interpretation that the portable data storage device disclosed in the Patent requires the use of an undisclosed, detachable cable (with two USB coupling devices: an

"A" plug at one end and a "B" plug at the other). This was conceded under cross examination.

21 The skilled addressee would interpret the Patent and conclude that the portable data storage device contains a USB "A" plug that is integrated into the body of the device to form a single, unitary device that can be plugged directly into the USB port of a computer. Numerous references are also made in the Patent to a USB plug that is able to plug directly into and be removed from the USB ports of computers and other devices.

Trek's case of patent infringement

Infringement of the patent claims

22 Before turning to specific acts of patent infringement, I have to consider whether DOK and Diskey (both products manufactured and sold by M-Systems; and distributed by Electec); and SD and BSD (both manufactured and sold by Ritronics) fall within the scope of the Patent. Images of two of these devices are reproduced below:

M-Systems' "Diskey"

Ritronics' "SlimDisk"

23 Claim 7 of the Patent specifically addresses USB variants of the ThumbDrive solution:

> 1. A portable data storage device comprising a coupling device for coupling to a computer serial bus, an interface device coupled to the coupling device, a memory control device and a non-volatile solid-state

> memory device; the memory control device being coupled between the interface device and the memory device to control the flow of data from the memory device to the coupling device.
>
> ...
>
> 7. A device according to any of the preceding claims, wherein the coupling device comprises a universal serial bus coupling device and the interface device comprises a USB drive.

24 Trek's experts testified that the Diskey, SD and BSD fall within the scope of claim 7. M-Systems does not deny that the DOK and Diskey contain each and every element of the claims of the Patent. When interrogatories were served, it was admitted that the Diskey contains the following elements:

(a) it is a portable data storage device;

(b) it includes a coupling device for coupling to a computer serial bus;

(c) it includes a memory control device;

(d) it contains a non-volatile solid-state memory device that is a read/write memory device;

(e) it includes a memory control device and a memory device;

(f) it contains a micro-controller operating as a memory control device;

(g) it includes a coupling device comprising a universal serial bus coupling device.

25 In its answers to interrogatories, Ritronics also admitted that the SD and BSD contain each of the elements of claim 7, namely a USB plug for coupling to the USB port of a host computer, an interface device connected to the USB plug,

flash memory for read and write functions and a memory control device to control the flow of data to and from the flash memory.

26 Ritronics' BSD contains each of claims 1–7 of the Patent. This was admitted in Ritronics' answers to interrogatories. Even though Ritronics obtained a patent for a fingerprint–access version of the Thumbdrive solution, such a product, even if it incorporates patented concepts (which are under opposition from Trek, who also filed an application for a patent for this solution on 22 March 2002, and obtained the patent on 23 April 2003, preceding Ritronic's application) can in any event infringe the Patent. There was some suggestion that the SD did not contain the write-protect element that is found in claim 5 of the Patent. However this runs counter to answers given in response to interrogatories and testimony presented in the course of the trial.

27 Based on the evidence before this court, there is no dispute that the defendants made, sold or offered for sale, or kept for disposal in Singapore, devices that were clones of the ThumbDrive. Claims 1, 5 and 7 were infringed by these devices. I now discuss how the activities of the defendants translate into infringing acts under the Patents Act.

Relevant statutory provisions

28 Trek has sought injunctions against the defendants from making, selling or disposing of any of the products that infringed the Patent. These are all acts which may not be carried out without the licence of the patent owner. Section 66(1) of the Patents Act states:

> Subject to the provisions of this Act, a person infringes a patent for an invention if, but only if, while the patent is in force, he does any of the following things in Singapore in relation to the invention without the consent of the proprietor of the patent:

> (a) where the invention is a product, he makes, disposes of, offers to dispose of, uses or imports the product or keeps it whether for disposal or otherwise;
>
> (b) where the invention is a process, he uses the process or he offers it for use in Singapore when he knows, or it is obvious to a reasonable person in the circumstances, that its use without the consent of the proprietor would be an infringement of the patent;
>
> (c) where the invention is a process, he disposes of, offers to dispose of, uses or imports any product obtained directly by means of that process or keeps any such product whether for disposal or otherwise."

29 Having determined that the various storage devices imported or disposed of fall within the scope of the Patent, I now turn to my findings with respect to the different categories of infringement submitted by Trek. I will preface my findings with the broad observation that there did not appear to be any dispute that DOK and Diskey (both products manufactured and sold by M-Systems; and distributed by Electec); and SD and BSD (both manufactured and sold by Ritronics) were made, launched or sold after the launch of the ThumbDrive at the CeBIT 2000 exhibition in 2000.

Infringing acts committed in relation to DOK and Diskey

30 DOKs (also known as Diskey, which is the name of the DOK sold in Singapore) were manufactured and sold by M-Systems, one of the defendants in this action. The business arrangement for the sale of DOKs showed the involvement of other defendants. Electec purchases DOK from M-Systems. The Chief Executive Officer (CEO) of M-Systems admitted in his affidavit that M-Systems is the supplier of Diskey to Electec in Singapore. Electec then supplies the DOK to FE Global, who then distributes and sells the DOK in Singapore. The CEO of FE Global and Electec confirmed this in his evidence. Invoices from M-Systems to Electec were also discovered in these proceedings to show that

Electec imported the Diskey into Singapore. There was also some evidence that Diskey was purchased from a shop called Portable World Pte Ltd. FE Global's name appears on the packaging and on the product registration and warranty card. It was admitted in evidence that FE Global is the "distributing and marketing agents in Singapore for the Diskey product on behalf of [Electec]". FE Global manages a website <www.diskey.com.sg>, in which the Diskey is offered for sale. It is available to buyers in Singapore.

31 Based on the admissions stated above, Trek also alleged infringement on the part of Electec and M-Systems, based on the disposal, offering to dispose, importing and/or keeping whether for disposal or otherwise, of the Diskey product.

Disposal through website dissemination

32 Trek also alleged that M-Systems had offered to dispose of the Diskey product in its website, by placing links through FE Global's and Electec's websites. I do not accept the evidence that each defendant has no control over the links that are made to other defendants' websites. Take the M-Systems website. It has "Singapore" on its list of countries where the DOK is sold. FE Global's name also appears under "Singapore" because the DOK continues to be sold by M-Systems through FE Global and Electec in Singapore.

33 M-Systems' CEO admitted that there was a distribution agreement "of one sort or another" between M-Systems and FE Global, to jointly promote the DOK product. FE Global's/Electec's CEO explained during cross examination that there was a business arrangement between the defendants which provided for mutual linking between the websites of the defendants, pointing to a common

enterprise between the defendants to promote and sell the DOK across many jurisdictions, including Singapore.

34 The defendants argued that Trek had not pleaded that the "offer" was made in Singapore. No authority was cited to support the suggestion that the absence of such pleading would be sufficient to defeat Trek's infringement claim. I was referred by Trek's counsel to *Bullen & Leake & Jacob's Precedents of Pleadings* (Brennan & William Blair gen ed) (Sweet & Maxwell, 14th Ed, 2001) at Vol 2 para 64.08, where it was said that the particulars of patent infringement only require the identification of the type of act within s 66 of the Patents Act. Equally tenuous was the defendants' argument that the network of websites did not show that M-Systems had "offered to dispose" in Singapore. They sought to draw an analogy with trade mark law, which requires the use of a sign in a particular jurisdiction where infringement is alleged. Adopting a more practical approach, Jacob J in *Euromarket Designs Inc v Peters* [2001] FSR 20 at [16] said that "there must be an inquiry as to what the purpose and effect of the advertisement in question is". It is clear that if one were to ask the question whether a reasonable user looking at the websites would understand that an offer to dispose of the DOK was being made in Singapore, the answer must, I think, be "yes". It is clear from the evidence that the primary M-Systems website provides an avenue for the user in Singapore to purchase the DOK with the link to the FE Global/Electec websites. There is an "offer to dispose" of the DOK in Singapore within s 66(1) of the Patents Act.

Conspiracy and joint tortfeasorship

35 The law on joint tortfeasorship can be divided into two broad categories: (a) where one party conspires with the primary party or induces the commission

of the tort; or (b) where two or more persons join in a common design pursuant to which the tort is committed.

36 Trek argued a case of conspiracy to infringe against the three defendants in Suit 609/2002. According to Trek's counsel, all three defendants have links via the other's websites to sell the Diskey product. It was further argued that these mutual links to each other's websites and the defendants' continued supply and sale of the DOK (despite clear notice of the Patent) is clear evidence that there was a conspiracy to infringe the Patent. I do not agree. A party will only be liable for conspiracy to infringe where it actually induces the infringement or there is evidence of an agreement or understanding to carry out acts of infringement: *Electro Cad Australia Pty Ltd v Mejati RCS Sdn Bhd* [1998] 3 MLJ 422; *Ong & Co Pte Ltd v Quah Kay Tee* [1996] 2 SLR 553. A party who sells or offers to sell or dispose of an article knowing that it is going to be used to infringe may assist infringement, but cannot be said – for the purpose of establishing a conspiracy – to have induced it: *CBS Songs v Amstrad* [1988] RPC 567 at 606. Even though M-Systems admitted that it gave indemnities to FE Global and Electec, I am not prepared to conclude that the court should automatically infer that an inducement has taken place with respect to continued acts of patent infringement. The threshold for conspiracy is a high one to cross.

37 Trek also alleged the second category of joint tortfeasorship against the three defendants in Suit 609/2002: where the acts constituting infringement were carried out in "furtherance of a common design". In *Morton-Norwich Products Inc v Intercen Limited* [1978] RPC 501 at 512, Graham J elaborated on the concept of "common design":

> As I understand it, persons whose respective shares in the commission of a tortuous act are done in furtherance of a common design are properly regarded as joint tortfeasors: see Clerk and Lindsell on Torts,

> 14th ed.; page 201, and the references *inter alia* to *The Khoursk* [1924] page 140 per Scrutton L.J. at page 155. It is clear from this that two persons who agree on common action in the course of and to further which one of them commits a tort in this country are joint tortfeasors. There is, as Scrutton L.J. said, one tort committed by one of them on behalf of and in concert with the other.

38 The observation may be made that for parties to operate in furtherance of a common design, it is not necessary for them to have mapped out a plan. Tacit agreement will also suffice: *Unilever Plc v Gillette (UK) Limited* [1989] RPC 583 at 609.

39 Counsel for Trek sought to equate the business arrangement between the defendants as amounting, *inter alia*, to a "common design" for the purpose of establishing joint tortfeasorship. They submitted that the following circumstances support the finding of a "common design":

(a) Invoices from M-Systems to Electec, which show that Electec imported the Diskey into Singapore, including invoices after 17 April 2002, after Trek had put the Defendants on notice of its Patent;

(b) Evidence of the CEO for M-Systems during cross-examination, where he agreed with Counsel for Trek that the DOK was (before and continued after this action) to be sold by M-Systems through FE Global and Electec in Singapore;[1]

(c) Evidence of the CEO for FE Global/Electec during cross-examination, where he agreed with Counsel for Trek that the

[1] NOE 5 May 2004 at p 44

business arrangement continues up to today and that Electec is still the distributor for M-Systems);[2]

(d) M-Systems had also issued indemnities to FE Global to encourage or facilitate the continued sale of the Diskey in Singapore. The CEO for FE Global/Electec said that the purpose of the indemnity was to enable FE Global to continue selling the DOK.[3]

40 The indemnities issued by M-Systems go some way to disprove the so-called "arms-length" basis of the dealings between the various defendants, as advanced by their counsel. As a result of the indemnities given, FE Global and Electec continue to import and distribute the DOK in the Singapore market. In the event of any damages being awarded against them, FE Global and Electec will be fully indemnified by M-Systems.[4]

41 Having considered the evidence, and the submissions of counsel, I am persuaded that a case of joint tortfeasorship has been made out against M-Systems, FE Global and Electec, based on the furtherance of a common design to infringe the Patent.

Making, sale or offer to dispose by Ritronics

42 As against Ritronics, Trek's pleaded claims of infringement refer to the making, disposal or offer to dispose, importing and/or the keeping for disposal or otherwise, of the SD and BSD. It was also alleged that Ritronics offered these

[2] NOE 5 May 2004 at p 110

[3] NOE 5 May 2004 at p 104

[4] NOE 5 May 2004 at p 106.

two products for sale on its website <www.ritron.com.sg>. Ritronics denied that these acts constituted infringement of the Patent. There is no merit to this denial.

43 Ritronics' managing director admitted that the SD, which, for all intents and purposes, is an identical copy of the ThumbDrive, was launched or made available in Singapore before July 2002. A webpage printout dated 22 May 2002 clearly informed visitors that SDs were being sold by Ritronics. There was also evidence that in May 2002 a third party was offered a distributorship from Ritronics to export or sell the SDs in Korea. [5]

44 The SD was also exhibited at a computer exhibition and, under cross-examination, Ritronics' managing director admitted that at least 100 SDs were brought to the exhibition, and 20 units were sold. In the course of cross-examination it also transpired that SDs were offered for sale or disposed of to members of the trade, including some retailers. Newspaper interviews were also given, where Ritronics reported that BSDs would debut in July 2002. These activities, together with website announcements (including those on <www.bioslimdisk.com>, registered to Ritronics), were all early advertisements which have been held by the English Courts to be infringements: *Gerber Garment Technology Inc v Lectra Systems Ltd* [1995] RPC 383 at 412. It is no defence for Ritronics to say that the 100 or so devices were sold or disposed of for "evaluation" purposes or for obtaining "technical feedback". In no way does this insulate them from Trek's infringement claim.

45 Ritronics' managing director also tried to move its Singapore operations to a Hong Kong company, Ritech International Ltd ("Ritech"), which is wholly owned by Ritronics. It is not sufficient for Ritronics to argue that Ritech is a

[5] NOE 29 April 2004 at pp 147, 150, 1520; 5 May 2004 at p 95

completely separate legal entity. The manner in which the operations were moved to Hong Kong and how SDs and BSDs were attributed to Ritech, would lead this court to question whether this course of conduct was designed to deflect liability on the part of Ritronics. The SD and BSD originated from Ritronics. The websites from which the devices are sold or offered for sale, namely <www.ritron.com.sg> and <www.bioslimdisk.com>, were and continue to be registered to Ritronics.

46 Having considered all the evidence, I conclude that Ritronics had made, disposed of or offered to dispose of the SDs and BSDs, or had kept them for disposal, within the meaning of ss 66 and 67 of the Patents Act. Trek has succeeded in making its case for infringement, subject to defences that are available to the defendants, which are discussed further below. Before addressing the prior art, I will turn to a novel application made by Trek during the litigation – to amend the Patent.

Application to amend the Patent

47 The law suits commenced by Trek were unfortunately interposed by an unprecedented application by its solicitors to amend the Patent during the proceedings. As presently drafted, the Patent discloses a portable data storage device (without any cable) that uses an integrated USB plug. On 28 March 2004, Trek applied to amend the Patent, in order to claim and clarify the true nature or extent of the ThumbDrive invention.

48 The proposed amendments were principally to claims 1 and 8 as follows (with changes tracked and underlined):

Claim 1

> A portable data storage device which can be directly plugged into a USB socket of a computer and which is operative to function as an alternative to a magnetic disk or CD-ROM, and which is capable of storing software for installation to the computer or of receiving and storing users's data present in the computer and which comprises a coupling device which is a USB plug for coupling directly to a USB socket on a computer , an interface device coupled to the USB plug , a memory control device and a non-volatile solid-state memory device; the memory control device being coupled between the interface device and the memory device to control the flow of data from the memory device to the USB plug .
>
> **Claim 1A**
>
> A portable data storage device according to Claim 1 that is more compact than a conventional magnetic disk or CD-ROM storage device.
>
> **Claim 8**
>
> A device according to any of the preceding claims wherein the USB plug and USB socket are replaced by an IEEE 1394 (Firewire) protocol plug and a Firewire protocol compatible socket respectively, and the interface device is a Firewire protocol driver.
>
> **Consequential portions on page 8 lines 24-25 to be deleted**

Prior art

49 The above amendments were sought to place sufficient distance between the Patent and five instances of prior art that were raised by the defendants in their challenge to the novelty and inventive step of the Patent. The prior art references are:

(a) A leaflet published by Aladdin Knowledge Systems Inc ("Aladdin") that shows a USB version of their parallel port software protection key. Aladdin is a leader in the field of Hardware against Software Piracy.

(b) US Patent No 6088755 ("Sony patent"), which discloses a proprietary interface method (mechanical, electrical and protocol) for allowing data that is captured on one system-type to be retrieved on a different system-type.

(c) European Patent Application 929043A1 ("TDK patent"), which describes a method of adding a secondary cable-connected interface to a pre-existing PC card. This would enable such an enhanced PC card to be used in systems that did not have a PC card socket.

(d) Singapore Patent Application No 200203303-3 (derived from PCT application PCT/US00/07087) ("Ban patent"), which discloses a method of building a cable-connected desktop storage device that enables flash modules to be attached via USB and operate as a file storage device.

(e) PCT Application WO 99/45460 (Estakhri) ("Lexar patent"), which discloses a cable-connected adaptor that allows pre-existing flash modules to be attached to a PC that does not have matching flash sockets.

50 It was apparent that the amendments were sought to buttress Trek's response to the defendants' invalidity claims.

The court's power to amend a patent during infringement proceedings

51 Section 83 of the Patents Act allows for a patent to be amended during infringement proceedings. Limitations are introduced under s 84(3) which states, *inter alia*, that no amendment shall be allowed under s 83 if it (a) results in the specification disclosing any additional matter; or (b) extends the protection conferred by the patent. If the amendments are allowed, then such amendments shall have effect and be deemed always to have had effect from the grant of the

patent. Trek's case was that its proposed amendments fell squarely within the parameters set by the Patents Act, and should be allowed.

52 Any amendments must also satisfy base-line criteria in s 25(5) of the Patents Act, which provides, *inter alia*, that the claims are to be clear and concise.

No disclosure of additional matter

53 The English courts have formulated a three-step test to determine whether any additional matter is disclosed by the amendment (in *Bonzel v Intervention Limited (No 3)* [1991] RPC 553 at 574):

(a) To ascertain through the eyes of a skilled addressee what is disclosed, both explicitly or implicitly, in the application;

(b) To do the same in respect of the patent as granted; and

(c) To compare the two disclosures and decide whether any subject matter relevant to the invention has been added by the proposed deletion or addition.

54 The Examiners' Guidelines for the European Patent Office similarly provide (at Part C-VI, 5.4):

> An amendment should be regarded as introducing subject-matter which extends beyond the content of the application as filed, and therefore unallowable, if the overall change in the content of the application (whether by way of addition, alteration or excision), results in the skilled person being presented with information which is not directly and unambiguously derivable from that previously presented by the application, *even when account is taken of matter which is implicit to a person skilled in the art*. [emphasis added]

55 As viewed by the skilled addressee, the Patent discloses a portable mass data storage device having an integrated USB "A" plug for a direct connection to the USB socket on a computer without an intervening cable. Trek's patent agents also confirmed on affidavit that what was proposed by the amendments was already disclosed in the Patent; no disclosure of additional matter or extension of protection was sought by this application to amend the Patent. It is also significant that the defendants' expert agreed, during cross-examination, that upon reading the Patent both in its unamended and amended form, a skilled addressee "would conclude that it discloses a USB memory storage device which is compact with an integrated plug".

No extension of protection

56 The evidence has suggested that what is being proposed does not extend the protection afforded by the Patent, but in fact limits the scope of patent protection, to the extent that the following embodiments are no longer claimed in view of amended claim 1:

(a) devices which are plugged indirectly;

(b) devices which do not use a USB plug

(c) devices which do not function as an alternative to a magnetic disk or CD-ROM

(d) devices which are incapable of storing software or the user's data.

The amendments are supported by the specifications of the Patent

57 An exercise must also be carried out to determine whether the amendments to the Patent are sufficiently disclosed in the existing specifications.

I am satisfied that they are, and reference may be made to the following pages and claims of the Patent:

(a) "which can be directly plugged into a USB socket of a computer"

Support

(i) Device described in relation to figure 1 on page 3, lines 21–22;

(ii) Page 5, lines 18–20

(iii) Page 6, lines 7–8; 16–17

(iv) Page 7, lines 21–22

(v) Page 9, lines 1–3

(b) "and which is operative to function as an alternative to a magnetic disk or CD-ROM"

Support

(i) Page 1, lines 13–22

(ii) Page 2, lines 6–11

(iii) Description of device as a whole

(c) "and which is capable of storing software for installation to the computer"

Support

(i) Page 4, lines 20–23

(ii) Page 7, lines 1–22

(d) "or of receiving and storing user's data present in the computer"

Support

(i) Page 4, lines 23–25

(ii) Page 7, line 24 to page 8, line 21

(e) "A portable data storage device according to Claim 1 that is more compact than a conventional magnetic disk or CD-ROM storage"

Support

(i) The Patent

(ii) Page 1, lines 13–22

(iii) page 2, lines 6–11

(iv) Page 9, lines 5–9

(v) Figure 1

(f) USB plug and socket are replaced by a Firewire protocol compatible plug and socket respectively

Support

(i) Claim 8 of the Patent

(ii) Page, lines 1-3

The defendants' objections to the proposed amendments

58 The defendants objected to the amendments, based on the scope of what the Patent (as filed) discloses. For example, they were of the view that the Patent (as filed) disclosed a device with an integrated plug. The evidence during cross-examination showed that the Patent (as filed) does disclose an integrated USB "A" plug. The objection raised has effectively been rendered academic. The amendments to the Patent would clarify that the Patent excludes embodiments which do not use a USB plug, and to that extent the amendment serves to restrict the scope of the Patent. The defendants also referred to the "socket 8" feature at the rear end of the device disclosed in the Patent. They said that the device would not work if other devices were attached to the socket, but the expert evidence appears to suggest that the device will work notwithstanding the presence of the "socket 8". In fact, the claims of the Patent do not refer to "socket 8", and the patentee, Trek, could not have intended to attach much importance to this feature. I accept the evidence of Trek's expert, that the invention with the "socket 8" feature refers to a device with an integrated plug that forms an appendage to a computer.

59 The defendants also submitted that the Philips D12 driver was *not* indicative that the device in the Patent has an integrated USB "A" plug. But it was precisely the fact that the Philips D12 driver would not, in accordance with the state of the art at the relevant time, have disclosed or pointed to the USB "A" plug, that informs the novelty and innovation of the integrated A plug.

60 It was the defendants' contention that if a disclosure teaches the use of a broad class of elements, a specific element within that class cannot be claimed.

They cited *Flexible Directional Indicators Ltd's Application* [1994] RPC 207 ("*Flexible*"). In *Flexible*, the application in suit related to a traffic bollard that was characterised by a co-polymer of ethylene and vinyl acetate ("EVA") as the material from which it was made. The scope of the patent as filed was defined by a statement which read, "According to one aspect of the present invention a bollard comprises a hollow body moulded from a compound of ethylene vinyl acetate and at least one other polymer material." During the examination of the application, the applicant introduced amended claims which were rejected by the examiner because it extended the scope of the patent, thus contravening s 76(2) of the UK Patents Act. The Patents Court dismissed the appeal. The application as filed did not disclose that the bollards could be made from EVA alone. It was limited to EVA and another polymer. The application as sought to be amended did extend the disclosure, even though the specific embodiment used EVA and another polymer. The court held that when the claims were considered together with the body of the specification, the skilled man would have known that proportions of the monomers in EVA could be selected to obtain the resilient material and would not have been surprised that EVA alone was claimed as being within the invention. This case does not assist the defendants, given that the proposed amendments in the present case actually limit the scope of the Patent as filed, and I am satisfied that the amendments relate to matters that were clearly and unambiguously disclosed in the application.

61 The defendants also argued that the following phrase in the proposed amendment to claim 1A, "more compact than a conventional magnetic disk or CD-ROM storage device", has no supporting disclosure. Their argument is that the disclosure only compares the size of the device with a "conventional portable data storage device" and not with a "conventional magnetic disk or CD-ROM storage device", as stated in the proposed amendment. This amounts to a trivial

distinction without any material difference. Even the defendants' own expert agreed with Trek's position that "conventional" in the context of a PC would mean something that is used as a storage medium, *ie* floppy disks and CD-ROMs. This objection cannot be sustained.

Amendments must be clear and concise

62 The defendants complained that the following phrase in the proposed amendment, "more *compact* than a *conventional* magnetic disk or CD-ROM storage device" [emphasis added] is unclear and not concise. It is telling that the defendants' expert had no difficulties using the words "compact" and "conventional" in relation to the defendants' devices, but still registered an objection of non-clarity in respect of these two words in the proposed amendment. It is clear that the Patent discloses a small, portable, unitary and integrated device. There should be no issue over what these two words mean, given the context in which they appear.

63 Another point of ambiguity was raised in relation to the proposed claim 1A. The court has to decide whether claim 1A is inherent in claim 1. Beyond this question, if it is answered in the negative, then the court will still have to decide if the Patent sufficiently supports the addition of claim 1A. In any event, the evidence of the patent agents clearly point to claim 1A being a dependent claim on claim 1. Hence it is also the case that claim 1A is supported by the Patent, based on the ample evidence given by the patent attorneys.

Discretion defined

64 The defendants also submitted substantially as to whether the court should exercise its discretion in favour of amending the patent specifications. The scope

of the discretion that is to be exercised in determining whether the amendments should proceed was set out in *Smith Kline & French Laboratories v Evans Medical Limited* [1989] FSR 561 ("*Smith Kline*") at 569. When a patentee applies to court to amend its patent specifications, the court considers:

(a) whether the patentee has disclosed all the relevant information with regard to the amendments;

(b) whether the amendments are permitted in accordance with the statutory requirements;

(c) whether the patentee delayed in seeking the amendments (and if so, whether there were reasonable grounds for such delay);

(d) whether the patentee had sought to obtain an unfair advantage from the patent; and

(e) whether the conduct of the patentee discourages the amendment of the patent.

65 The issue is whether the above principles are still valid in the context of modern patenting. In a more recent decision of *Instance v CCL Label Inc* [2002] FSR 27 ("*Instance*"), Pumfrey J expressed the view (at [42]) that the approach taken by the courts in *Smith Kline* was "anachronistic and out of step with a modern law of patents". The basis for this view is compelling (see [39]):

> I have to admit that I do not find the reasoning that underpins this approach entirely satisfactory. In the days before claims it was understandable. The patent was either valid or invalid, and to identify the need to disclaim part of the invention was to admit invalidity. To sue on a patent known to be invalid was seen to be wrong and unfair. When an application to disclaim was made, the patentee was put on terms that it would not start further infringement proceedings until the

> application to disclaim had been disposed of. With the advent of claims, and later provision for relief for infringement of a patent only partially valid, albeit on terms which would nomally include amendment ... and on condition that the specification had been framed in good faith and with reasonable skill and knowledge, the rationale for this approach becomes less clear.

66 In considering whether discretion should be exercised in favour of granting an amendment, the shift in judicial attitudes appears to have been towards the scrutiny of the conduct and motives of the patentee. In *Mabbuchi Motor KK's Patents* [1996] RPC 387, Jacob J took the view that the overriding principle upon which the court acts is whether there was "grave misconduct by the patentee" or "bad faith (or fraud or dishonesty or insincerity)" and whether that has an effect on the public. As Jacob J said (at 397):

> [A] refusal of a necessary amendment, which could of course lead to revocation, 'would be harsh and would only seem to provide justice if there are very exceptional circumstances'. Aldous J. primarily based his succinct statement of principle upon the judgments in *C. Van der Lely NV v Bamfords Ltd.*, where Pearson L.J. referred to 'grave misconduct by the patentee in relation to the patent' as being the test. Pearson L.J. was looking for 'bad faith (or fraud or dishonesty or insincerity or whatever it may be called)'. I must here, therefore, look to see whether there are very compelling reasons for refusal of the amendment.

67 The editors of the CIPA Guide to the Patents Act (Sweet & Maxwell, 5th Ed, 2001) observed (at para 75.06) that the general approach of the courts in applying its discretion has "become more lenient". It appears to be the position now that an amendment to a patent should be permitted unless there are compelling reasons against amendment. The approach which appears to find some sympathy amongst patent practitioners and commentators is that unless there are compelling reasons against allowing the amendments, amendments are generally allowed. Underlying this approach is the transparency of the patent system in Singapore and other countries in the world. Provision is made for the examination and scrutiny of patent applications. Examination reports are

available for public inspection, and so, adverse parties are able to evaluate the validity and strength of patents which have been filed. Adverse parties are therefore less likely to be surprised (and consequently prejudiced) by subsequent amendments which may be sought by the patentee, even if this takes place in the course of patent litigation.

68 The defendants resisted the amendments by, firstly, saying that Trek has not disclosed all relevant matters to explain the circumstances relating to the amendments. The scope and extent of the duty of disclosure was set out by the English Court of Appeal in *Oxford Gene Technology v Affymetrix Inc (No 2)* [2001] RPC 18 ("*Oxford Gene*"). I set out the following passage (at [19]):

> [W]hen a patentee seeks amendment, the court requires him to place before it the relevant facts and matters upon which it is to exercise its discretion. This is particularly appropriate where some amendment proceedings are conducted without the presence of an opponent...It follows that the court is concerned with whether to exercise its discretion to allow amendment for that reason and the patentee must turn his mind to that issue so as to be able to inform the court of the relevant facts. Any disclosure should be limited to that issue and only ordered if necessary....From the transcript of the hearing before Laddie J, it seems that practitioners believe there to be an obligation upon a patentee to trawl through his documents to see whether they are relevant to the exercise of discretion, whatever the reason put forward for the amendment. That results in considerable expense and is not required under modern principles. The obligation of good faith requires the patentee to put forward correct reasons for the amendment. If there be facts relevant to the exercise of the discretion for those reasons then those facts need to be put before the court.

69 It is also clear that the disclosure does not compel the disclosure of privileged documents. The disclosure is still subject to privilege, which may be waived at the election of the patentee. If privilege is not waived, the court is also not entitled to draw an adverse inference against the maintenance of privilege.

This is clear from the following passage from *Oxford Gene* at [21], which bears quoting *in extenso*:

> There is no obligation upon a patentee in amendment proceedings to waive privilege in respect of any document. In so far as my judgment in Bonzel v Intervention Ltd [1991] RPC 231 has led to that belief – it was wrong. In his judgment in the Kimberly-Clark case, Laddie J said at page 237 that the obligation upon a patentee who sought amendment was to make full and frank disclosure "was so strong that effectively the patentee was put under pressure to waive his entitlement to legal professional privilege." I suspect that statement reflects a body of opinion among practitioners. For the reasons I have given, it is based upon a misapprehension as to the obligation on a patentee seeking amendment. It is also contrary to the law relating to privilege. As was pointed out in WC Wentworth v JC Lloyd (1864) 10 HLC 589, *the maintenance of privilege does not enable the court to draw an adverse inference against the person who maintains his privilege. The obligation to disclose material facts and matters does not require the disclosure of documents and I can see no warrant for a patentee throwing all his documents at the court as a policy or caution. Of course, a patentee's case may best be advanced by waiver of privilege, but the decision whether to waive privilege is one for him and not for the court. Certainly the obligation to tell the court of the facts material to the reason for amendment cannot act as a hidden obligation to waive privilege.* [emphasis added]

Alleged non-disclosure by Trek

70 The defendants claimed that Trek had failed to discharge its duty of full and frank disclosure to the court in five areas, namely:

(a) the circumstances surrounding how Trek became aware of two out of seven instances of prior art cited by the defendants (the "Jones and Satore references") from November 2000, and in particular, whether Trek was advised that either of the prior art necessitated the amendment to the Patent, which it was now seeking;

(b) whether Trek deleted claims 1 to 8 of its corresponding US patent to overcome any of the cited prior art raised by the defendants;

(c) the identities of the recipients of the numerous letters which Trek sent, enforcing the Patent (so that the defendants could contact these recipients to determine if they were materially affected or prejudiced by the receipt of Trek's letters);

(d) that most of the claims in Trek's corresponding US patent had been refused acceptance; and

(e) that Trek's Australian patent, despite being previously accepted as amended, was now subject to further examination for patentability by the Australian examiner.

These allegations will be discussed in turn.

A. Jones and Satore references

71 It is clear that Trek knew of the Jones and Satore references in November 2000, and this was disclosed in evidence. However the references cannot be regarded as relevant prior art for the purposes of the application for amendment. The defendants pointed out that Trek chose to claim privilege in relation to advice that the two references did not constitute relevant prior art. No inference should be drawn against Trek over its continued claim of privilege over this document(s), and this is clear from *Oxford Gene*. A telling feature of the apparent lack of relevancy of these two references is that the defendants chose not to cross examine Trek's experts on these two references.

B. Trek's US patent application

72 The defendants suggested that Trek amended its US patent application ("the US Application") in March 2001 because of the Jones and Sartore references, the implication being that the prior art references must be relevant. Counsel for Trek correctly pointed out that the US Application relates to a different invention, and it was not the corresponding patent to the Patent. For this reason, it was also not material that Trek did not disclose a Final Rejection to the US Application by the US Patent Office – it pertains to a different subject matter. In the context of the US Application, the disclosure of these two prior art references have no bearing on the Patent. It should also be noted that the burden of disclosure in the US patent system is onerous, and patentees have to render complete disclosure of all known prior art references (whether or not relevant).

C. Trek's Australian and Canadian applications

73 Similar considerations apply for Trek's Australian and Canadian applications. In these countries, all prior art references had to be made, regardless of direct relevance. The defendants also alleged that Trek failed to give full and frank disclosure that further objections had been raised against Trek's applications in Australia. During cross-examination, it transpired that events had superseded the evidence that was filed in these proceedings on 28 November 2003.

D. Identities of the recipients of Trek's letters

74 The defendants also submitted that Trek did not provide full and frank disclosure since it blanked out the identities of the recipients of the letters sent by Trek. This was clearly not a tenable argument, in view of the fact that the letters were disclosed pursuant to a court order that the identities be redacted.

75 Overall, I did not consider that the allegation of non-disclosure made by the defendants related to matters that were germane to Trek's amendment application.

Has there been undue delay in bringing the amendment application?

76 The applicant for an amendment to his patent must act expeditiously, from the time he discovers the relevant prior art. The court still has to be satisfied, based on the facts and circumstances of this case, that Trek acted reasonably, and without undue delay. Mere knowledge of some prior art does not mean that Trek knew of the need to amend the Patent (see CIPA Guide at p 326). It is entitled to take the advice of patent agents on whether there is a need to amend, and what form such amendment should take. Pumfrey J best summarised the court's approach in *Instance* at [38]:

> In making decisions as to the need to amend on the basis of the advice received from a competent patent agent, a patentee cannot normally in my judgment, be criticised. In this case, the advice was given by a competent professional adviser and received and considered by the individual who was not conversant with the details of the law relating to anticipation and who entrusted his professional advisers to provide the basis for decision. I should be loath in such circumstances to consider that the patentee had been guilty of culpable delay, the more so since the point upon which the need to amend turns is not free from difficulty.

77 Trek does not dispute that it became aware of the TDK and Lexar patent references by way of notification from the defendants' solicitors on or about 15 May 2002. It became aware of the Aladdin and Sony patent references on or about 20 May 2002, when it was served, *inter alia*, with M-Systems' objections based on validity and prior art. I agree with Trek's submissions, based on the above principles that the appropriate juncture to question whether the amending party has been guilty of unreasonable delay is the time when it was first made aware of the need to amend.

78 The first time Trek was made aware of the need to amend the Patent was shortly before it applied to amend the New Zealand patent, on or about 30 October 2002, after consultation with patent agents from various jurisdictions. One has to appreciate the complexity of the exercise of consultation. Trek had to co-ordinate with its patent agents in various jurisdictions to come up with the form of amendments that would be allowed under the laws and practices of different countries. Trek proceeded with the amendment to the Patent on 28 March 2003. The amendments were applied for after following a professionally driven process.

79 I do not believe that in the circumstances of this case, Trek acted with unreasonable delay to bring its application for post-grant amendments. The defendants continued to introduce prior art into the litigation, so the targets were constantly shifting. Even as of March 2003, the chronology shows that the defendants had not finalised its list of prior art objections. Ritronics' prior art pleadings were not finalised until 2 May 2003. The urgency was also compounded by the fact that trial was fixed for 28 July to 22 August 2003.

80 The defendants have not succeeded in showing this court that there was any bad faith or reprehensible conduct on the part of Trek. Furthermore, the amendments which have been sought actually serve to limit the scope of the Patent, and do not add subject matter to the Patent. Most notably, certain embodiments are no longer claimed, namely devices which are plugged indirectly, devices which do not use a USB plug, devices which do not function as an alternative to a magnetic disk or CD-ROM, and devices which are incapable of storing software or the user's data.

81 For these reasons, Trek has sufficiently established a case for the amendments to the Patent, and I so order.

Defences

82 Each of the defendants' devices also infringe amended claims 1 and 7 of the Patent. I note that Trek's expert evidence on this issue was not rebutted by the defendants' experts or evidence. A case of infringement has been established with respect to each device based on the amended and unamended versions of the Patent.

83 The defendants raised two substantive defences to Trek's infringement claim:

(a) the lack of novelty and inventiveness of the invention as expressed in the patent; and

(b) misrepresentation concerning inventorship, and/or ownership of the Patent.

84 By way of precursor it should be noted that although the defendants challenged Trek's application to amend the Patent on the grounds of invalidity, the defendants did not, in their submissions and evidence, distinguish between the amended and un-amended claims.

85 I shall deal with each of the defences in turn.

Reference to prior art – whether the Patent fails for lack of novelty or inventive step

Novelty

86 The novelty question is decided by asking whether an invention forms part of the state of the art (s 14 of the Patents Act). That is, whether the prior art anticipated the invention. As was stated in *Hills v Evans* 4 De G F & J 288; 45 ER:

> [T]he antecedent statement must, in order to invalidate the patent, be such that a person of ordinary skill and knowledge of the subject would at once perceive and understand and be able to practically apply the discovery without the necessity of making further experiments...the information given by the prior publication must, for the purpose of practical utility, be equal to that given by the subsequent patent.

87 The following principles apply to determining anticipation:

(a) The prior art documents (which contain patent specifications and other literature) must be construed as if the court had to construe it at the date of publication, to the exclusion of information subsequently discovered by a reader skilled in the art to which they relate having regard to the state of knowledge in such art at the relevant date. An *ex post facto* analysis is not appropriate. Subsequent events or matters must be disregarded. (*General Tire & Rubber Company v The Firestone Tyre and Rubber Company Limited* [1972] RPC 457 ("*General Tire*") at 485; *Minnesota Mining & Manufacturing Co v Bondina Ltd* [1973] RPC 491 at 522);

(b) The court must not combine or "mosaic" disparate pieces of prior art in order to arrive at the invention in question. Each document should be considered separately; and

(c) The reader skilled in such art is a person of competent but average technical skill, who is unimaginative.

88 A reference to the following passage from *General Tire* (at 486) is also appropriate:

> To anticipate the patentee's claim the prior publication must contain clear and unmistakable directions to do what the patentee claims to have invented; ... A signpost, however clear, upon the road to the patentee's invention will not suffice. The prior inventor must be clearly shown to have planted his flag at the precise destination before the patentee.

89 As stated earlier, the Patent discloses a portable compact mass storage device with an integrated USB plug that directly plugs into the USB socket of a host computer without any cable-connection interface. I accept the evidence of Trek's experts, which shows that the cited prior art references (more than 46 in number) consist of storage devices that either (a) are not mass storage devices to begin with or (b) are mass storage devices that employ a different design approach. In relation to the latter, the prior art devices either require a connection cable to interface with the host computer or are secured and seated within the housing of the host computer. The defendants' reference to miscellaneous publications and products are also either general articles about USB or do not establish prior publication.

90 It is also significant that the defendants confined their closing submissions to the Lexar, TDK, Ban and Aladdin prior art references. I would note that with the exception of Aladdin, the other three prior art references relate to devices with a cable. They also did not disclose any device with an integrated plug. It cannot be said that these devices anticipate the Patent. I accept the evidence of Trek's expert, where he explained these devices were introduced into the market at a time when USB ports sat together with other expansion ports (serial and parallel

ports) at the back of a desktop computer. The use of a cable obviously made a device more user friendly.

91 The Lexar, Ban and TDK references do not disclose any device with an integrated plug, and this is not disputed. The other instances of prior art that were pleaded by the defendants similarly make reference to cabled devices (*eg* Sandisk Imagemate, Fuji card reader, *etc*). In so far as none of the prior art references discloses a device with an integrated plug, they do not invalidate the Patent by anticipation. The three references also do not disclose a data storage device which is unitary and integrated. They typify data storage devices in the prevailing state of the art – a removable storage medium that is inserted into a reader/writer which is in turn connected to a computer or tower by means of a cable.

92 The same cannot be said for the Aladdin. It does disclose an integrated plug and a unitary and integrated device. However, being a security device, it is neither a mass storage device, which the ThumbDrive is, nor does it teach a skilled addressee how to create a mass storage device. In my view, given that the "mass storage device" is a material embodiment of the Patent, for the Aladdin to destroy the novelty of the ThumbDrive, it must "be such that a person of ordinary knowledge of the subject would at once perceive and understand and be able practically to apply the discovery without the necessity of making further experiments [and] ... the information ... given by the prior publication must, for the purposes of practical utility, be equal to that given by the subsequent patent" (*Hills v Evans* (1860) 31 LJ Ch 457 at 463). Given that it is not a mass storage device, it fails to meet this threshold.

93 For the above reasons, the defendants have failed to show that any of the prior art discloses an integrated mass storage device with an integrated plug. The

novelty challenge obviously fails because the entire subject matter of the Patent (both unamended and amended versions) comprises much more – a portable compact mass storage device with an integrated USB plug that directly plugs into the USB socket of a computer without a cable connection.

Inventive step

94 According to s 15 of the Patents Act, an invention shall be taken to involve an inventive step if it is not obvious to a person skilled in the art. Oliver LJ postulated a test for obviousness in *Windsurfing International Inc v Tabur Marine (Great Britain) Ltd* [1985] RPC 59 ("*Windsurfing*")at 73:

> (1) Identify the inventive concept embodied in the patent in suit;
>
> (2) The court then assumes the mantle of the normally skilled but unimaginative addressee in the art at the priority date, imputing to him what was, at that date, common general knowledge in the art in question;
>
> (3) Identify what, if any, differences exist between the matter cited as being "known or used" and the alleged invention;
>
> (4) The court then asks itself the question whether, viewed without any knowledge of the alleged invention, those differences constitute steps which would have been obvious to the skilled man or whether they require any degree of invention.

95 At the outset, Trek tried to argue that Aladdin was not a relevant piece of prior art for the purposes of considering the inventive step; yet they considered it in the novelty enquiry. There is nothing in ss 14 and 15 of the Patents Act to allow this court to exclude the Aladdin from the state of the art as defined in the

Patents Act. That said, it does not preclude the court from finding that in assuming the mantle of a skilled addressee it would not have considered a security device to be something that could have been used to create an improved data storage device. It would be too onerous for a skilled addressee to be expected to consider an alternative use or improvement of a security device (like the Aladdin) in data storage. The skilled addressee is after all, unimaginative (as stated in the *Windsurfing* formulation).

96 It is clear that there was no device available in the market or known generally that could have led a skilled but unimaginative person to invent the ThumbDrive, or to look upon it as the obvious next step in technology. An evaluation of the Lexar, TDK and Ban references do not reveal any teachings of an integrated plug. Contrary to what the defendants submit, the Patent does not teach a device with a cable (thus making a finding of obviousness easier). The defendant's expert not only agreed with Trek's experts that the prior art does not teach the use of an integrated plug, he also admitted that this was an inventive step.

97 Not only is the integrated plug not disclosed in the prior art, the skilled but unimaginative addressee would not have been able to invent such a device. The evidence has satisfied the court that the specifications only made reference to two types of connections for a USB device, both of which required use of a cable. The differences between the prior art and the Patent are apparent.

98 Moreover the prior art does not lead a skilled addressee to view an integrated device as the obvious next step in the technology. The Lexar, TDK and Ban references point to the prevailing state of the art as comprising a removable storage medium that was capable of being inserted into a two-component device

which consisted of a reader/writer, which in turn is connected to the computer by cable. Against this evaluation of the prior art, it would not have been obvious to a skilled addressee to have thought of creating an integrated unitary device. The Aladdin device, being a security as opposed to a storage device, would also have been disregarded by a skilled (but unimaginative) addressee from being a serious candidate from which the invention of the ThumbDrive was obvious. I also note the palpable lack of any evidence showing that the industry was moving in the direction of creating a unitary and cableless device. This puts even greater inventive distance between the Patent and the state of the art. Finally it is also noteworthy that the defendants' own experts admitted that a skilled addressee would take various steps in order to arrive at the ThumbDrive. The Patent is not the obvious next step. In this respect I disagree with the defendants' claim that it is obvious to go from a two-piece, cable-connected prior art to the ThumbDrive invention.

99 For the above reasons I also conclude that the defendants have failed to show that the Patent (whether unamended or amended) lacked inventive step.

Effect of commercial success

100 The ThumbDrive has shown itself to be a development of great utility, and has also satisfied a long-felt want in the trade. In both cases the inference of inventiveness is strong. The CIPA Guide to the Patents Acts states:

> The question of obviousness is probably best tested, if this be possible, by the guidance given by contemporaneous events ... if an invention has resulted in the solution of a problem which has been troubling industry for years and achieves immediate success upon its introduction, then the suggestion after the event that the step was obvious inevitably rings a little hollow.

101 The credit that should be accorded to the commercial success of an invention is also well set out by Tomlin J in *Samuel Parkes & Co Ltd v Cocker Brothers Ltd* (1929) 46 RPC 241 at 248:

> [W]hen once it had been found ... that the problem had waited solution for many years and that the device is in fact novel and superior to what had gone before, and has been widely used, and used in preference to alternative devices, it is ... practically impossible to say that there is not present that scintilla of invention necessary to support the patent.

102 The findings of novelty and inventive step with respect to the Patent are fortified in this case by the accolades that greeted the ThumbDrive when it was launched, and the subsequent commercial success enjoyed by Trek. The multitude of clone storage devices that followed in its wake, including the defendants' devices, is further indication of a profitable venture.

Misrepresentation

103 Section 80(1)(g) [now s 80(1)(f)(ii)] of the Patents Act provides for the revocation of a patent in the event that the patent was obtained on a misrepresentation:

> (1) Subject to the provisions of this Act, the Registrar may, on the application of any person, by order revoke a patent for an invention on (but only on) any of the following grounds:
>
> ...
>
> (*g*) the patent was obtained on a misrepresentation.

104 Similar provisions (not *in pari materia*) exist under s 32(1)(*j*) of the UK Patents Act 1949 (repealed) and s 100(1)(*j*) of the Australian Patents Act. The current UK Patents Act 1977 does not have a similar provision.

Alleged misrepresentations

105 The defendants alleged that Trek had misrepresented to the registrar of patents at the time Trek sought a patent for the ThumbDrive invention:

(a) M-Systems claims that an employee of the Trek's related company S-Com Pte Ltd ("S-Com") was one of the inventors of the ThumbDrive invention and hence, Trek is not the full owner of the ThumbDrive Patent.

(b) M-Systems claims that there was a misrepresentation to the Registrar of Patents when Trek did not name one of the inventors when it applied for the Patent.

(c) Ritronics alleges that 2 former Trek employees had developed the ThumbDrive invention and that the rightful owner of the ThumbDrive invention is a Chinese company called Netac Technology Ltd.

Misrepresentations must be material

106 In David Young *et al*, *Terrell on the Law of Patents* (Sweet & Maxwell, 14th Ed, 1994) at para 5.130, it is stated that a misrepresentation must also be *material* so as to revoke a patent:

> It is irrelevant whether or not there was deliberate falsehood by the patentee if the Crown was in fact misled, but "if false suggestion is alleged, it must be established on the basis of the documents in which the alleged false suggestion was made – the onus being, of course, on the objector." In Intalite International *NV v Cellular Ceilings Ltd (No. 2)* [1987] RPC 532 Whitford J held that the mere fact that a misleading statement might be found in the body of a specification was not sufficient to establish invalidity on the ground of the false suggestion. The statement must have misled the Comptroller into granting the patent. The patent is obtained upon the suggestions or representations set out in the recitals to the patent grant itself and falsity in any of them

> will be sufficient to invalidate the patent, if false statement is of such materiality that the patent can be said to be "obtained" on it.

107 As seen from the above passage, the onus is on the defendants to show that the misrepresentation must actually have deceived the registrar of patents into granting the Patent (see also Blanco White, *Patents for Inventions and the Protection of Industrial Designs* (Stevens & Sons, 5th Ed, 1983) at para 4-1002). In the Australian decision of *Prestige Group (Australia) Pty Ltd v Dart Industries Inc* 19 IPR 275 at 279, Lockhart J articulated a test for material misrepresentation:

> I would state the test, however, in different terms, namely, whether the conduct constituting the false suggestion or representation materially contributed to the Commissioner's decision to grant the patent even if other circumstances or causes also played a part in the making of that decision. It is sufficient if the conduct is a *material inducing factor* which led to the grant. [emphasis added]

Relationship between S-Com and Trek; Poo Teng Pin and Marcus Cheng

108 The inventive concept underlying the ThumbDrive was developed by one Poo Teng Pin ("Poo") and one Marcus Cheng ("Marcus"). They were both employees of S-Com and Trek. S-Com and Trek were wholly-owned subsidiaries of the parent company, Trek 2000 International Ltd. Both S-Com and Trek were very close. There was some evidence of an agreement or understanding between both companies at the material time to register patents in the name of Trek, and so it came to pass. Both Marcus and Poo were co-inventors of the patent, but curiously, Marcus, who was Head of the Engineering Department and tasked to liase with patent agents and prepare the patent application, named himself as the sole inventor. Trek subsequently came to realise that Poo had been omitted from the patent application. Marcus subsequently left the employ of Trek. Trek

managed to contact Marcus so that he could confirm via declarations that Poo was a co-inventor of the Patent.

109 I am satisfied, after hearing the evidence, that once Trek discovered the omission of Poo as a co-inventor, it took the following steps to rectify the error:

(a) A letter was written to the World Intellectual Property Organisation (WIPO) as soon as Trek's patent agent in Singapore was notified;

(b) WIPO issued an official notification in November 2002, stating that the identity of the inventor had been corrected;

(c) A copy of the WIPO notification was sent to the Intellectual Property of Singapore on 13 December 2002; and

(d) A copy of the WIPO notification was also sent to patent agents all over the world, so that national registers could be rectified accordingly.

110 The cause of the omission was inadvertence. There was no evidence to suggest a deliberate omission on the part of Marcus. The error of mis-stating inventors happens quite frequently. In Singapore patent practice there is a form for this and other forms of errors. One can only infer that it may be a common occurrence.

Assignment agreement

111 When Trek found out that they had made a mistake in not including Poo as co-inventor, an assignment agreement was drawn up, as a matter of prudence, for S-Com to transfer whatever residual rights it had in the invention to Trek.

There was some discrepancy over the date of execution, but the assignment agreement appears to have been prepared in or about June 2002.

112 Section 19(2) of the Patents Act sets out categories of parties who are entitled to the *grant* of the Patent (to be contrasted with parties who are entitled to *apply* for the Patent under s 19(1)). Section 19(2) provides:

> A patent for an invention may be granted —
>
> (a) primarily to the inventor or joint inventors;
>
> (b) in preference to paragraph (a), to any person or persons who, by virtue of ... an enforceable term of any agreement entered into with the inventor before the making of the invention, was or were at the time of the making of the invention entitled to the whole of the property in it (other than equitable interests) in Singapore; or
>
> (c) in any event, to the successor or successors in title of any person or persons mentioned in (a) or (b) or any person so mentioned and the successor or successors in title of another person so mentioned,
>
> and to no other person.

113 Trek's entitlement to the invention *ie* its right to be granted the Patent, is derived from two sources:

(a) Through its employee, Marcus, under section 19(2)(*b*) (not a disputed point); and

(b) From an assignment of S-Com's right to the invention in favour of Trek. Under s 19(2)(*c*), Trek is entitled to S-Com's right to be granted the Patent as a successor-in-title to S-Com.

114 The assignment agreement does not need to be formally executed, since it is an assignment of the rights to the invention, as opposed to the assignment of

"any right in a patent". In the case of the latter, formal execution (*ie* in writing, signed by both parties) is required under ss 41 and 43 of the Patents Act. In its closing submissions, Trek submitted that the assignment agreement was not necessary and was only drafted with the intention of assigning any residual rights of the invention that S-Com might own to Trek, and was done only as a matter of prudence. By the time the assignment agreement was drafted (June 2002), the Patent had already been granted correctly in Trek's name in April 2002, pursuant to the agreement between S-Com and Trek that all patent applications be filed in the name of Trek. Trek argued that there had been no misrepresentation to any of the relevant authorities as to the identity of the owner. The Patent was correctly applied for, and granted in the name of Trek.

Trek's errors did not materially contribute to the decision whether or not to grant the Patent

115 Even though there may have been factual inaccuracies in Trek's application process, at the end of the day, the court should ask whether the inaccuracies materially contributed to the decision to grant the Patent. In *Speedy Gantry Hire Pty Ltd v Preston Erection Pte Ltd* 40 IPR 543 at 560, the court held that even if the patent applicant's statement alleging an assignment was false, such false suggestion or representation "would not have contributed materially to the commissioner's decision to grant the patent and so long as [the applicant] was entitled pursuant to section 34 of the 1952 Act to apply for the patent, *the particular grounds upon which that entitlement arose were immaterial*" [emphasis added]. The English Patents Court has also pronounced, in the case of *Coflexip Stena Offshore Limited's patent* [1997] RPC 179 ("*Coflexip*") at 193, that "[f]rom the public point of view, what really matters is that the register should show who the proprietor is. How he came to be the proprietor is of no or little importance."

116 The evidence in this case was sufficient to show that Trek had a basis to hold itself out to the registrar of patents to be the owner of the Patent. The operative presumption must therefore be that Trek is entitled to be the owner of the Patent (s 19(3) of the Patents Act). Whether it is registered or not, the assignment agreement carries evidentiary weight in that it clarifies beyond doubt that S-Com had transferred all rights in the invention to Trek. Trek was entitled to file the patent application as owner.

117 The omission of Poo's name as co-inventor was an error that Trek acted with reasonable dispatch to repair. From the correspondence admitted into evidence I fail to see how the omission of Poo, and the subsequent rectification, could be said to materially affected the grant of a Patent in a self-assessment system. None of the patent offices in other countries appeared to have had any difficulty amending the patent application to include Poo as co-inventor. I also note that no evidence was tendered on behalf of the defendants to show how the identity of the inventor "materially contributes" to the decision of the registrar of patents whether to grant the Patent.

Allegation that the rightful owner of the ThumbDrive invention is a Chinese company called Netac Technology Ltd

118 Ritronics also brought a claim for misrepresentation against Trek. It is based on a patent filed and obtained in China (Chinese patent no 99117225) ("the Chinese Patent") by two individuals, Steven Cheng XiaoHua ("Cheng") and Frank Deng GuoShunn ("Deng"). Cheng and Deng own and manage a company in China called Netac Technology Ltd ("Netac"). They used to be former employees of Trek.

119 Ritronics alleged that the invention in the Patent must have been stolen from these two individuals or Netac. For Ritronics to succeed in this allegation, the court has to be satisfied that the inventive concept of the Chinese Patent is the use of an integrated USB "A" plug for a portable data storage device. More importantly, there must be compelling evidence that Trek usurped the concept. On both these counts, Ritronics cannot succeed based on the evidence before the court.

120 As a preliminary observation, the Chinese Patent and corresponding applications to the European Patent Office ("EPO") were filed by Netac *after* the Patent's priority date. It does not constitute prior art in the present proceedings.

121 While the Chinese Patent discloses a device that is broadly similar in the function of data storage, there are some notable differences between the Chinese Patent and the ThumbDrive. The Chinese Patent teaches and explicitly requires the use of one of three different cables to connect between the data storage device and the host computer to enable data exchange. The integrated plug element is also missing. In the course of cross-examination, defendants' counsel made the argument for the first time that the Chinese patent actually discloses a device with a USB "A" plug, like the ThumbDrive invention which the user connects with a cable to the host computer. I do not accept this argument for the following reasons:

(a) There is no disclosure or reference made to a USB "A" plug in the Chinese Patent, whether integrated or otherwise.

(b) Netac's corresponding EPO application expressly describes the need for and use of a "socket" component in the device, rather than a

plug. There are also three different types of cables described in the application.

(c) The Chinese Patent was not directed towards an extension cable with a USB "A" socket.

(d) The references to "socket" in the Chinese Patent refer to a USB "B" socket.

(e) The use of the term "plug" in the English translation of the Chinese Patent refers to the mechanical action of plugging a device rather than describing a physical component.

(f) The corresponding EPO application disclosed the use of the Philips D12 driver, which teaches the use of a "B" socket, rather than a USB "A" plug. This is confirmed by the circuit diagram of the D12 circuit.

122 Any suggestion that Trek stole the ThumbDrive invention from the Netac's EPO application is also tenuous. The defendants referred to a figure which disclosed a device with a USB "A" plug. The EPO application was filed seven months after the launch of ThumbDrive at CEBIT 2000. The chronology does not support Ritronics' theory that Trek stole the invention. There was also some evidence of a commercial collaboration between Netac and Trek, the latter holding 20% of the shares in the former. Moreover Ritronics did not produce any direct evidence that Trek had usurped the ThumbDrive solution from Deng and Cheng, who were employees of Trek at one point in time. There was no evidence that Trek secured Netac's silence by financial reward. There was also no evidence that Netac had produced a prototype device in August 1999. Ritronics also relied on certain documents which confirmed that Deng and Cheng are the rightful

owners. It emerged that the documents were evidence of a business collaboration between Netac and Trek. Cheng and Deng worked in Trek, and derived some knowledge of flash memory management from two cable-connected development boards. Thereafter they founded Netac and approached Trek for funding. Trek proceeded with a collaborative arrangement with Netac since there was a possibility that Netac had a useful or novel invention that could eventually be exploited by Trek. A confidentiality agreement was executed by the parties, with Netac requesting Trek to be a manufacturer of its products and distributor for all territories outside China. There was however no evidence of any inventions, patents or other materials that were subsequently disclosed by Netac to Trek. Netac went on to file a patent for the "USB Flash Disc", and asked Trek to pay the filing charges.

123 Whatever may have been Trek's reasons for investing in Netac, there was no evidence of any conspiracy between the parties to conceal the fact that Cheng and Deng were the rightful owners of the Patent. There is no evidence to show that they can lay claim to the ownership of the patent. Ritronics made serious allegations against Trek, for example doctoring payment vouchers, which were uncalled for and should have been avoided altogether.

124 For the above reasons, I conclude that the defendants' submissions based on s 80(1)(*g*) of the Patents Act are not well founded.

Innocent infringement – s 69 of the Patents Act

125 The defendants claim to be innocent infringers, and rely on s 69(1) of the Patents Act, which states:

> In proceedings for infringement of a patent, damages shall not be awarded and no order shall be made for an account of profits against a

> defendant who proves that at the date of the infringement he was not aware, and had no reasonable grounds for supposing, that the patent existed.

126 The defendants have to prove that, at the date of the infringement, they were not aware and had no reasonable grounds for supposing that the Patent existed. The evidence suggested that patent notifications were issued by Trek:

(a) Advertisements in MASNET, the Straits Times and Business Times by Trek 2000 International;

(b) Notification letters to Flextech Holdings Limited, and to Sony Electronic Devices Marketing (Singapore) on 17 April 2002.

127 FE Global and Electec were put on notice on 17 April 2002, when they received the notification. The M-Systems were put on notice, at the latest, by 22 April 2002. The evidence showed that the infringing product was purchased by Trek's representative on 24 April 2002. It would be reasonable to infer that as at the date of the infringement, the defendants already had notice of the existence of the Patent. The defendants cannot claim to be innocent infringers under s 69(1) Patents Act. In any event, invoices dated after 17 April 2002, which passed from M-Systems to Electec, showed that sales continued notwithstanding the notification. Ritronics also continued to deal with SDs after Trek's solicitors wrote to them in May 2002. Ritronics' evidence was that it intended to move operations to a company (Ritech) that was incorporated in Hong Kong to avoid infringement. Ritech is nothing more than an agent of Ritronics, and the evidence showed that Ritronics/Ritech continued to deal in infringing products after receiving a letter from Trek's solicitors.

No damages should be awarded because of s 75 of the Patents Act

128 The defendants also argued that they could not be liable for any damages (in the event that this court makes a finding of infringement) because Trek had not registered the assignment agreement with the Intellectual Property Office of Singapore ("IPOS") within six months of the execution. Section 75 provides that when a party becomes a proprietor of a patent by virtue of an assignment, he is entitled to damages only if he registers the transaction or instrument within six months of its date (only applicable to transactions, instruments and events falling within the ambit of s 43 of the Patents Act). Section 75 does not provide a defence. It only provides a benefit to defendants "adventitiously": see *Coflexip* at 193.

129 At the stage of closing submissions, Trek's position was that the assignment agreement was not registrable under s 43 of the Patents Act, since it purportedly assigned a right to an invention, as opposed to right(s) in a patent or application to a patent. Trek subsequently tried to register the assignment agreement with IPOS, and this was the subject of another application by the defendants, which is dealt with below.

130 The defendants cannot rely on s 75 because Trek have always been the lawful owner of the Patent on record. This was how the Patent was applied for, and a presumption operates that they are the lawful owner of the Patent.

Defendants' allegations of groundless threats

131 The defendants also brought a counterclaim for groundless threats under s 77 of the Patents Act. Given that this court has concluded that the Patent is valid, and that the defendants did commit infringement of the Patent, within the

framework of s 77 (and in particular s 77(2)), the defendants will not succeed in their claim for groundless threats of patent infringement. In any event, I am of the view that the two letters, which were at the centre of this part of the dispute, were nothing more than letters exploring the possibility of a business collaboration, and any allegation that groundless threats were made is misconceived. This is quite apart from the fact that a finding of infringement (as in this case) is a complete answer to any allegation made under s 77 Patents Act.

Further evidence in Summons in Chambers No 4463/2004/Z

132 The defendants did not give up their challenge. In October 2004, after parties had closed their respective cases, with closing submissions exchanged, the defendants made an application to court by way of SIC 4463/2004/Z for further evidence to be adduced. They submitted that this was in response to new matters raised by Trek in paras 29.113, 29.114 and 31.24 and Annex A of Trek's Closing Submissions. The defendants also wanted to file supplementary evidence of Trek having taken steps in the EPO and the UK Patent Office, which were contradictory to Trek's position in the Singapore proceedings. They accused Trek of bad faith in failing to disclose the contradictory steps as well as the EPO's revocation of acceptance of Trek's application to the EPO. Even though I doubted if the additional evidence was of any real significance to the case (following the test in *Vernon v Bosley (No 2)* [1997] All ER 614 at 627), I gave leave for supplementary affidavits to be filed so as to prevent any risk of injustice to the parties.

133 The new evidence traverses the following issues:

(a) Correspondence between Trek's patent agents, Lloyd Wise, and IPOS, which concerned an application to register the assignment agreement under s 43 of the Patents Act; and

(b) Post-trial developments to the prosecution of Trek's patents in the EPO and the UK Patent Office

Registering the assignment agreement under s 43 of the Patents Act

134 In its Closing Submissions, Trek made reference to a letter dated 7 May 2004 from Lloyd Wise to IPOS enclosing an application to register the assignment agreement between S-Com and Trek. While Trek had previously maintained that the assignment agreement is not registrable under s 43 of the Patents Act, it made an application to register the transaction *ex abundanti cautela*. The court is fully aware of the position taken by the parties in their submissions, and will give appropriate weight to this new development. The apparent inconsistency in Trek's position, which the defendants allude to, is a very far cry from saying that the defendants have established on the evidence, taken as a whole, that Trek are not the lawful proprietor or owner of the Patent. In para 4 of IPOS' letter of response, it said that "[i]f Trek Technology (S) Pte Ltd is not the sole proprietor as mentioned above, it would appear that an error was made at the point of filing this application. If so, please take the necessary actions to rectify the situation." This is, not unexpectedly, a *conditional* response to Lloyd Wise's letter. Trek have always maintained their position that since all rights in the Patent had been assigned to Trek prior to the date the application was filed, there was no requirement for such an application to register the assignment agreement. This new evidence does not take the defendants very much further, especially given that the assignment agreement took place after the Patent was

filed. In the agreement, no reference was made to the Patent; therefore, no rights in it were ever assigned.

Trek's UK patent and EPO application

135 In the course of trial the Plaintiffs made reference to their corresponding UK patent and EPO application in support of the proposed amendments to the Patent.

136 The defendants submitted by way of new evidence that after trial the EPO raised objections to Trek's EPO application, on grounds that were substantially similar to the Defendant's objections against the Patent. After the trial, Trek applied on 2 July 2004 and 24 June 2004 to amend its UK patent and its EPO application respectively. The defendants submitted that these amendments contradicted Trek's position taken in relation to the same subject matter at trial, and should have been disclosed to the court in Trek's Closing Submissions, which were filed on 6 July 2004. The defendants submitted that by not doing so Trek has breached its duty of full disclosure owed to the court when applying to amend the Patent. The amendments made to the UK patent and the EPO application include:

(a) Introduction of disclaimers to claim 1 of the UK patent and EPO application that contradict the position taken on the construction of claims of the Patent;

(b) Replacing the phrase "directly plugged into" with "directly introductible into and removable from" in claim 1 of the UK patent and EPO application; showing Trek's lack of belief in the validity of the phrase; and

(c) Adding the phrase "to permit the transfer of data from one computer to another" to claim 1 of the UK patent and EPO Applications, which phrase has been stated by Trek to be necessary to distinguish prior art such as Aladdin from the ThumbDrive. Hence the amendments sought by Trek are insufficient to distinguish prior art.

137 The defendants overstate the case when they say that Trek placed extensive use on their UK patent and EPO application. It has remained Trek's position that for the purposes of the amendment proceedings, any foreign applications made by Trek are irrelevant to the issues raised in the amendment proceedings. The foreign proceedings are referred to for illustrative value only.

138 Amendments were made by Trek to the EPO application because of an alleged prior art (EP1102172, referred to as the "Yao reference") The Yao reference *does not* form part of the relevant state of the art in Singapore, and at no time have the defendants pleaded it as relevant prior art. The EPO issued a summons for Trek to attend oral proceedings. The summons was only issued on 19 August 2004, after Trek filed its Closing Submissions. The EPO's objection is provisional and does not serve as confirmation that Trek's EPO application will not be allowed. The disclaimers were introduced by Trek to their UK patent and EPO application so as to overcome the limitations of the Yao reference. I would also note that Trek has also made further refinements to the wording of its UK patent and EPO application.

139 The defendants alleged that the change in the form of words used, that is, the replacement of "directly plugged into" with "directly introducible into and removable from" indicated Trek's own lack of belief that the words "directly plugged into" would be allowed. On the contrary, in the counter-statement that

was filed by Trek in the UK proceedings, it was submitted that the meaning of the terms "directly plugged" and "coupling directly" were both apparent and clear from the specifications of the patents as filed. The terms mean physically connecting a first device to a second device without an intervening cable. There is no contradiction as this has always been the position taken by Trek.

140 As for Trek's addition of the words "to permit the transfer of data from one computer to another", these words do not amount to an admission that the Aladdin prior art reference renders the Patent obvious. Looking at the counter-statement filed, Trek maintained its position with regard to the Aladddin prior art reference, using substantially the same submissions made in the present proceedings.

141 Having considered these latest developments in the UK and the EPO, I am unable to accept that they add any real significance to the outcome of the case. The principle of territoriality allows this court to independently determine the outcome of the Patent and its amendments. The court is aware that patent practice, procedure and prosecutions vary from country to country. Trek should be expected to take whatever decisions necessary to secure patent rights in each country that it requires protection.

Conclusion

142 For the above reasons, I would allow Trek's claims in Suit 609/2002/K, and dismiss the counterclaim. I also grant an order in terms of Notice of Motion No 83 of 2003/Y. Suit 604/2002/N is dismissed with costs. Damages are ordered to be assessed. I will hear parties on costs and other consequential orders.

Claims in Suits 609/2002 and 672/2002 allowed. Counterclaim in Suit 609/2002 dismissed. Claim in Suit 604/2002 dismissed.

Lai Kew Chai
Judge

Davinder Singh SC, Tony Yeo and Joanna Koh (Drew & Napier) for the plaintiff in Suit 609/2002 and the defendant in Suit 604/2002;
Jason Chan and Tan Wee Meng (Allen & Gledhill) for the plaintiff in Suit 672/2002;
P Sivakumar and Daryl Ong (P Sivakumar & Co) for the plaintiff in Suit 604/2002 and the defendants in Suit 609/2002;
G Radakrishnan (Rada & Associates) for the defendant in Suit 672/2002.

Trek Technology (Singapore) Pte Ltd
% Lloyd Wise
Commonwealth House
1-19 New Oxford Street
LONDON
WC1A 1LW

The Patent Office
Patents Directorate

Concept House
Cardiff Road, Newport
South Wales NP10 8QQ

Examiner: 01633 814746
E-mail: nigel.hanley@patent.gov.uk
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Fax: 01633 814444
Minicom: 08459 222250
DX 722540/41 Cleppa Park 3
http://www.patent.gov.uk

Your Ref: SH/LH/JEC/58132
Application No: GB 0207849.1

Patents Act 1977: Report of telephone conversation between Steven Howe and Examiner Nigel Hanley held 12th & 16th June 2003.

Further to our telephone conversations of 12th and 16th June I can confirm that I have received your divisional application, GB 0312704.0, which claims priority from this case. I hope to be able to issue the combined search and examination request within the next two weeks.

I can also confirm that at this moment in time the parent application appears to be in order for grant.

If you have any further queries please do not hesitate to contact me at the above address.

Nigel Hanley
(Examiner)

If you feel that this report is inaccurate, please let me know.

PARTNER	SH	FILE NO.
TA		58132
RECORDS	TM	

A Portable Data Storage Device

The invention relates to a portable data storage device, and in particular, a portable data storage device for a computer.

Conventional data storage devices generally fall into two categories. The first category is electronic, solid-state memory devices such as read only memory (ROM) and random access memory (RAM). These memory devices are generally fitted within the computer. They are not intended to be removable or portable so that they may be used on different computers, for example, to permit the transfer of data from one computer to another computer.

The second type of device is surface based data storage devices in which data is stored, typically, on the surface of a disk or tape. Examples of surface storage devices are magnetic disks and CD ROMs. Such data storage devices require a mechanical drive mechanism to be installed in or coupled to the computer to permit the data on the storage device to be read by the computer. In addition, such memory devices are limited by the surface area of the storage device, and the combination of the storage device and the drive mechanism for reading data from the storage device is generally bulky and/or delicate due to the moving parts that are required within the drive mechanism and/or storage device.

In accordance with the present invention, there is provided a portable data storage device comprising a coupling device for coupling to a computer serial

bus, an interface device coupled to the coupling device, a memory control device and a non-volatile solid-state memory device; the memory control device being coupled between the interface device and the memory device to control the flow of data from the memory device to the coupling device.

An advantage of the invention is that by providing a portable data storage device comprising a coupling device with an interface device, memory control device and a non-volatile solid-state memory device, it is possible to provide a portable data storage device which may be coupled to a computer having a serial bus port and which does not include moving parts or require a mechanical drive mechanism to read the data from the data storage device.

Preferably, the non-volatile solid-state memory device may be a read/write memory device, such as a flash memory device.

Preferably, where the memory device is a read/write memory device, the memory control device controls the flow of data to and from the memory device.

Typically, the data storage device further comprises a manually operated switch movable between a first position in which writing of data to the memory device is enabled, and a second position in which writing of data to the memory device is prevented.

An example of a data storage device in accordance with the invention will now be described to the accompanying drawings, in which:

Figure 1 is a schematic block diagram of a portable data storage device;

Figure 2 is a flow diagram showing the initial setup of the data storage device by a software supplier;

Figure 3 is a flow diagram showing the initial setup of the data storage device by an end user; and

Figure 4 is a flow diagram showing operation of the data storage device.

Figure 1 shows a data storage device 10 which includes a USB plug 1 which is coupled to a USB interface device 2. The USB interface device 2 is coupled to a micro-controller 3 which is coupled to a flash memory 4. The micro-controller

3 includes a read only memory (ROM) 5 which stores a program to control the operation of the micro-controller 3.

The operations performed by the micro-controller 3 include comparing passwords entered by a user with a corresponding password stored in the flash memory 4 to determine whether the user is authorised to access the contents of the flash memory 4. The program stored in the ROM 5 also controls the data flow to and from the flash memory 4 and can also detect whether the computer to which the memory device 1 is coupled has installed software programs which correspond to passwords stored in the flash memory 4. The micro-controller 3 can automatically retrieve passwords from the installed software to compare with passwords stored in the flash memory to verify that a user of the computer is authorised to access and run the software. In addition, the program stored in the ROM 5 also permits the setting of a password in the flash memory by a software supplier to correspond to the password contained in software supplied to a user. Typically, the password may correspond to the serial number of the software.

The flash memory 4 is typically divided into a number of different sections or zones. Typically, the flash memory is divided into two zones and each zone has a unique password. If the data storage device 10 is supplied with packaged software, the software serial number can be set in one zone to be the password to permit a user to access and use the software. The other zone, which can be used typically for storing a user's data, may have a separate password which is set by the user. Typically, the passwords are stored in a secure location of the

flash memory in an encrypted form. The encryption, decryption, data flow control and USB protocol are all managed by the micro-controller 3.

The micro-controller 3 also includes a random access memory (RAM) 6 which is a temporary storage area to permit functioning of the micro-controller 3. In addition, a manual switch 7 is coupled between the flash memory 4 and the micro-controller 3. The manual switch 7 is movable between a first position in which a user may write data to the flash memory 4 and a second position in which data is prevented from being written to the flash memory 4.

The device 10 also includes a USB socket 8 that is coupled directly to the USB plug 1 and permits other USB devices to be coupled to the USB via the device 10. For example, if a user wishes to increase memory space, a USB plug 1 of a second memory device 10 may be connected to the USB socket 8.

Figure 2 is a flow diagram showing the set up procedure for the device 10 for a software supplier when the software supplier intends to supply the device as an authentication device for the software. Firstly, the plug 1 of the device 10 is plugged into 20 to a USB socket on a computer. After the device 10 has been plugged into the USB socket on the computer, a communication is established 21 between the computer and the device 10. The software supplier has pre-installed installation software on the computer which is run by the operator. From the pre-installed software, the operator selects password set up installation 22, in response to which the pre-installed software requests the operator to enter a password or serial number corresponding to the software

with which the device 10 is to be supplied. The password or serial number is then encrypted 26 and stored 27 in the flash memory 4.

Figure 3 is a flow diagram showing the initial set-up of a password for zone 2 of the flash memory 4 by an end user. The device 10 is typically supplied with driver software that is loaded by the user onto the computer prior to set-up of the device. To set-up the password for zone 2 the user plugs in 20 the device 10 into a USB port on the computer and communication 21 is established between the computer and the device 10. The user then runs the driver software and the driver software enters a password installation set-up mode 23 for zone 2. The user then enters 28 a password that they wish to use to prevent unauthorised access to zone 2 of the flash memory 4. The password entered is then encrypted 29 and stored 30 in the flash memory 4.

After an end user has performed the initial password set up procedure described above and shown in Figure 3, when a user plugs in 20 the device 10 to a USB port on a computer, the computer will establish a communication 21 with the device 10 and firstly, checks 33 an installation status flag stored in the flash memory 4 (see Figure 4). If the status flag is "Y", the device 10 outputs 34 an "OK" flag to the computer. The micro-controller 3 the instructs the computer to issue a request 35 to the user to select the zone they wish to enter. If the status flag is "N", the device does not output an "OK" flag to the computer, and goes straight to step 35. In response to the request 35 for zone selection, the user selects 36 either zone 1 or zone 2.

If zone 1 is selected, the device 10 assumes that the user wishes to install software on the computer which is stored in the flash memory 4 and requests 37 the appropriate password for confirmation that the user is authorised to install the software. The micro-controller 3 receives the password entered by the user, retrieves the zone 1 password stored in the flash memory 4, decrypts the zone 1 password and compares it with the password entered by the user to authenticate 38 whether the user is authorised to install the software. If the passwords do not match, the device 10 prompts the computer to request 37 the user to enter the password again.

If the password entered by the user matches the password stored in the flash memory 4, the micro-controller 3 starts 39 the software installation from the flash memory 4 to the computer. In order to install software, the computer sends 40 a read/write command in USB format to the micro-controller 3 for data, the micro-controller 3 retrieves the requested data from the flash memory 4 and sends 41 the data to the driver 2. The driver 2 converts 42 the data to PC format and outputs the data to the computer through the USB plug 1. The micro-controller 3 then checks 43 whether the software installation is complete. If the operation is not complete, the operation returns to step 40. If the installation of the software is complete, the status flag stored in the flash memory 4 is changed to "Y" and the device 10 may then be removed 45 from the USB socket on the computer.

If a user selects zone 2, the micro-controller 3 sends a command to the computer to request 46 the user to enter the password for zone 2. When the

user enters the password, the computer sends the password to the micro-controller 3. The micro-controller 3 retrieves the password for zone 2 from the flash memory 4, decrypts 47 the password and compares it with the password entered by the user. If the password entered by the user is incorrect, the operation returns to step 46 and the computer requests 46 the user for the password again.

If the password entered by the user is correct, the user has access to zone 2 of the flash memory 4 to read data from the flash memory 4 and to write data to the flash memory 4. However, data can only be written to the flash memory 4 if the manual switch 7 is in the position to permit data to be written to the flash memory 4. In order to read or write data from or to the flash memory 4 a read or write command is sent 48 by the computer in USB format to the micro-controller 3. In response to the read or write command the micro-controller 3 either retrieves 49 data from the flash memory 4 and sends it to the driver 2 for conversion 50 to PC format and then to be output to the computer or receives data from the driver to write it to the flash memory 4.

The micro-controller 3 then determines 51 whether the read or write operation is complete. If the operation is not complete it returns to step 48. If the operation is complete the operation terminates 52.

An advantage of the device 10 described above is that it provides a portable data storage device for a computer which does not require a mechanical operated reading/writing device. In addition, the device 10 has no moving parts.

This enables to data storage device 10 to be more compact than conventional portable data storage devices.

CLAIMS

1. A portable data storage device which can be directly plugged into a USB socket of a computer and which is operative to function as an alternative to a magnetic disk or CD-ROM, and which is capable of storing software for installation to the computer or of receiving and storing user's data present in the computer and which comprises a coupling device which is a USB plug for coupling directly to a USB socket on a computer, an interface device coupled to the USB plug, a memory control device and a non-volatile solid-state memory device; the memory control device being coupled between the interface device and the memory device to control the flow of data from the memory device to the USB plug.

2. A device according to claim 1 in which the memory control device is operative to receive a password and compare it with a corresponding password stored in the memory device to determine whether access to the contents of the memory device is authorised.

3. A device according to claim 1 or claim 2, wherein the memory device is a flash memory device.

4. A device according to any preceding claim, wherein the memory control device controls the flow of data to and from the memory device.

5. A device according to any of the preceding claims, further comprising a manually operated switch movable between a first position in which writing of

data to the memory device is enabled, and a second position in which writing of data to the memory device is prevented.

6. A device according to any of the preceding claims, wherein the memory control device comprises a micro-controller.

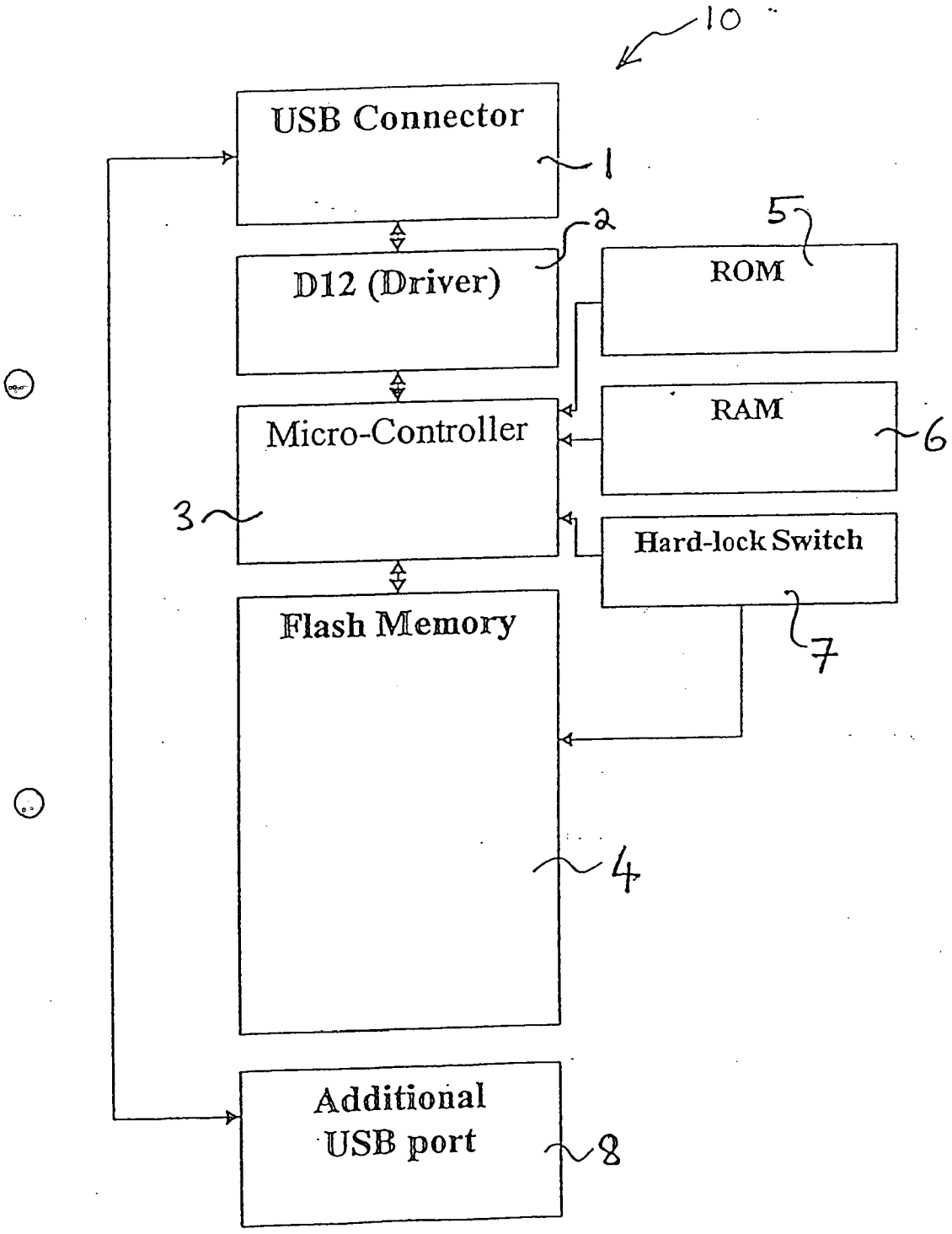
10
USB Connector
1
2
D12 (Driver)
5
ROM
Micro-Controller
RAM
6
3
Hard-lock Switch
Flash Memory
7
4
Additional
USB port
8

Figure 1

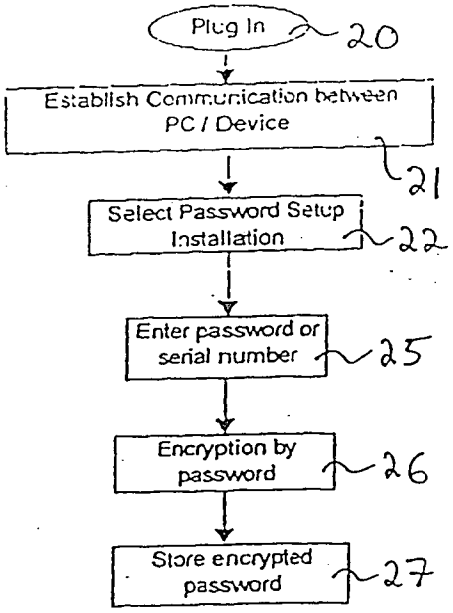

Figure 2

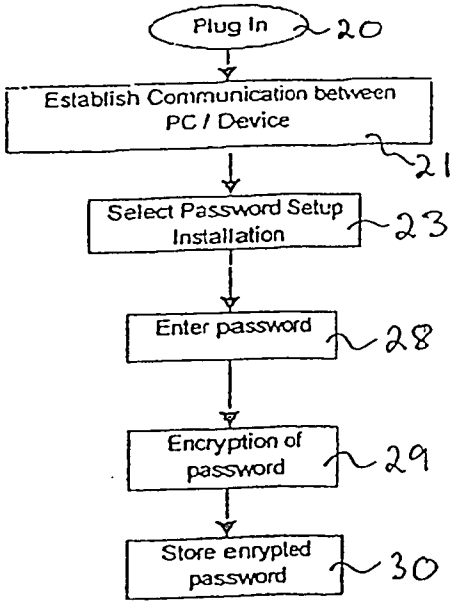

Figure 3

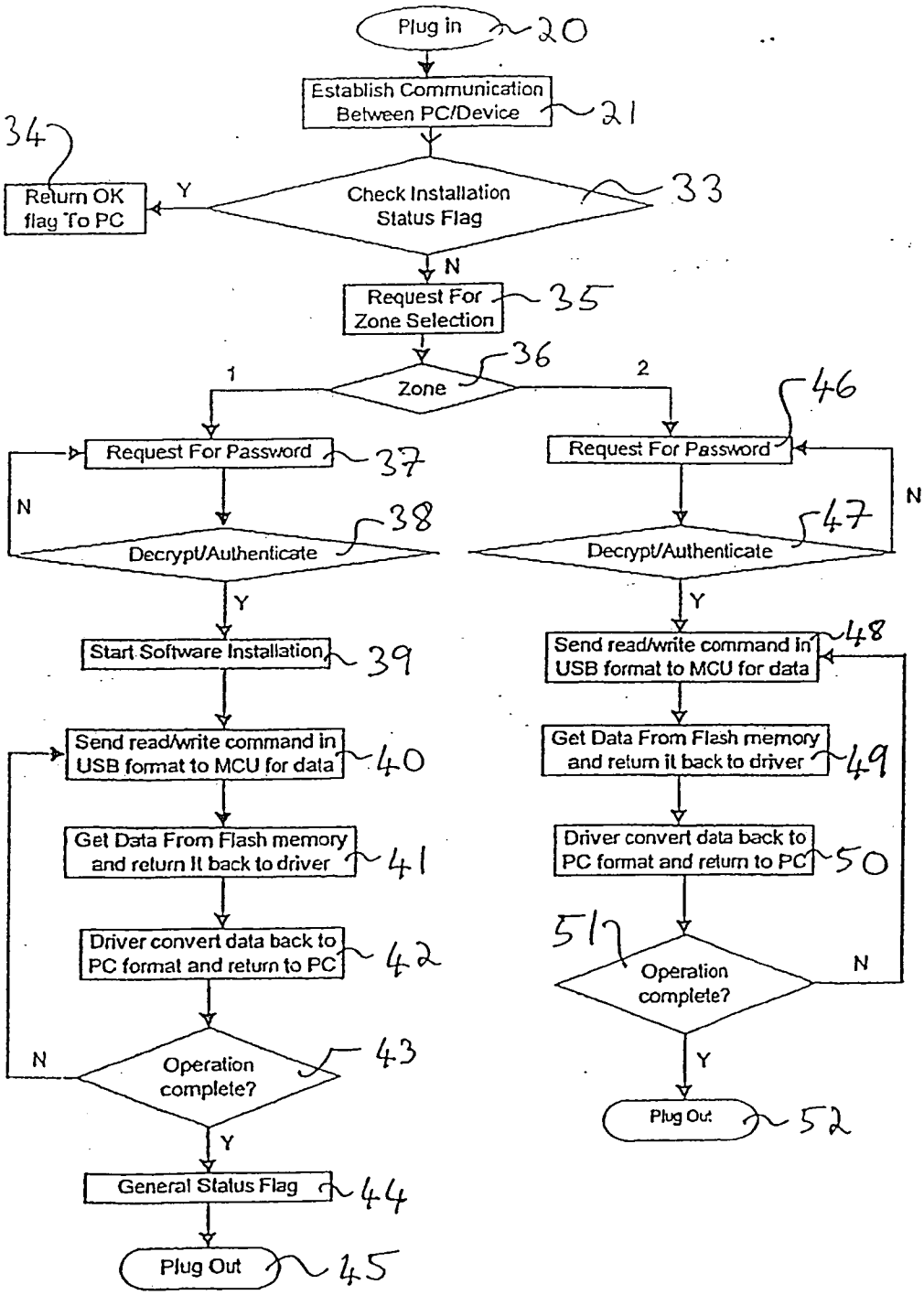
Plug in
20
Establish Communication Between PC/Device
21
34
Return OK flag To PC
Y
Check Installation Status Flag
33
N
Request For Zone Selection
35
Zone
36
1
2
46
Request For Password
37
Request For Password
N
38
Decrypt/Authenticate
47
Decrypt/Authenticate
N
Y
Y
Start Software Installation
39
Send read/write command in USB format to MCU for data
48
Send read/write command in USB format to MCU for data
40
Get Data From Flash memory and return it back to driver
49
Get Data From Flash memory and return it back to driver
41
Driver convert data back to PC format and return to PC
50
Driver convert data back to PC format and return to PC
42
51
Operation complete?
N
N
43
Operation complete?
Y
Y
General Status Flag
44
Plug Out
52
Plug Out
45

Figure 4

Intellectual Property Office of New Zealand
Te Pou Rāhui Hanga Hou

LETTERS PATENT

Number 518169

ELIZABETH THE SECOND, by the Grace of God Queen of New Zealand and Her Other Realms and Territories, Head of the Commonwealth, Defender of the Faith; To all to whom these presents shall come, Greeting:

WHEREAS pursuant to the Patents Act 1953 an application has been made for a patent of an invention for

A portable data storage device

(more particularly described in the complete specification relating to the application)

AND WHEREAS

TREK 2000 INTERNATIONAL LIMITED, 30 Loyang Way, #07-13/14/15, Loyand Industrial Estate, Singapore

(hereinafter together with his or their successors and assigns or any of them called "the patentee") is entitled to be registered as the proprietor of the patent hereinafter granted:

Address for service: BALDWIN SHELSTON WATERS, Level 14, NCR House, 342 Lambton Quay, Wellington, New Zealand

NOW, THEREFORE, We by these letters patent give and grant to the patentee our special licence, full power, sole privilege, and authority, that the patentee by himself, his agents, or licensees and no others, may subject to the provisions of any statute or regulation for the time being in force make, use, exercise and vend the said invention within New Zealand and its dependencies during a term of twenty years from 21 February 2000 and that the patentee shall have and enjoy the whole profit and advantage from time to time accruing by reason of the said invention during the said term:

AND WE strictly command all our subjects whomsoever within New Zealand and its dependencies that they do not at any time during said term either directly or indirectly make use of or put into practice the said invention, nor in any way imitate the said invention without the consent, licence, or agreement of the patentee in writing under his hand, on pain of incurring such penalties as are prescribed by law and of being answerable to the patentee according to law for his damages thereby occasioned:

PROVIDED ALWAYS:

(1) That these letters patent shall determine and become void if the patentee does not from time to time pay the renewal fees prescribed by law in respect of the patent:

(2) That these letters patent are revocable on any of the grounds prescribed by the Patents Act 1953 as grounds for revoking letters patent:

(3) That nothing in these letters patent shall prevent the granting of licences in the manner in which and for the considerations on which they may by law be granted:

(4) That these letters patent shall be construed in the most beneficial sense for the advantage of the patentee.

IN WITNESS whereof We have caused these letters patent to be signed and sealed on 12 May 2003 with effect from 21 February 2000.

Neville Harris
Commissioner of Patents, Trade Marks and Designs

FP1233

92

ASSIGNMENT

THIS AGREEMENT is made the 3 day of June 2000

BETWEEN

S-COM System (Singapore) Pte Ltd, a Singapore corporation of 30 Loyang Way, #07-13/14/15 Loyang Industrial Estate Singapore 508769

hereinafter referred as "the Assignor" of the one part,

AND

Trek Technology (Singapore) Pte Ltd, a Singapore corporation of 30 Loyang Way, #07-13/14/15 Loyang Industrial Estate Singapore 508769,

hereinafter referred to as "the Assignee" of the other part.

WHEREAS:

A) The Assignor jointly owns the rights to the invention of **PCT Patent Application PCT/SG00/00029** (hereinafter referred to as "the Patent Application").

B) The Assignor was the employer of POO Teng Pin at the time the invention described in the said Patent Application was made as part of POO Teng Pin's employment, and accordingly is the first owner of the invention under section 49(1)(a) of the Singapore Patents Act.

C) The parties hereto have agreed that the rights should be transferred by the Assignor to the Assignee on the terms hereinafter defined and for the consideration hereinafter set forth in all countries.

NOW THIS ASSIGNMENT WITNESSETH:

1. In consideration of the sum of US$1 now paid by the Assignee to the Assignor (the receipt whereof is hereby acknowledged), the Assignor hereby assigns absolutely to the Assignee free from encumbrances:

   (A) ALL of its right title and interest in and to the Patent Application and, as of the effective date hereinafter defined, all rights and powers arising or accrued therefrom to the intent that the grant of the patent shall be in the name of and vest in the Assignee;

   (B) the right to apply for prosecute and obtain patent or similar protection throughout the world in respect of the invention claimed in the Patent

Application including the right to claim priority therefrom to the intent that the grant of any patent(s) or similar protection shall be in the name of and vest in the Assignee.

2. This Assignment is to have an effective date of 3 June 2002.

3. The Assignor further covenants that at the request and cost of the Assignee, the Assignor shall:

(A) assist the prosecution of the Patent Application to grant and shall execute all documents and do all acts as may be necessary or proper to obtain the acceptance of the Patent Application and for procuring the grant of the patent; and

(B) execute all such documents and do all such acts as may reasonably be necessary or proper to secure the vesting in the Assignee of all rights assigned hereunder.

IN WITNESS whereof this Assignment has been executed by duly authorized representatives on behalf of the parties hereto.

Signed by
for and on behalf of **S-COM System (Singapore) Pte Ltd**
in the presence of:

Name: FOO Kok Wah
Designation: Director, Operations

Signed by
for and on behalf of **Trek Technology (Singapore) Pte Ltd**
in the presence of:

Name: FOO Kok Wah
Designation: Director, Operations

FP1233

94

ASSIGNMENT

THIS AGREEMENT is made the 3 day of June 2000

BETWEEN

Trek Technology (Singapore) Pte Ltd, a Singapore corporation of 30 Loyang Way, #07-13/14/15 Loyang Industrial Estate Singapore 508769

hereinafter referred as "the Assignor" of the one part,

AND

Trek 2000 International Ltd, a Singapore corporation of 30 Loyang Way, #07-13/14/15 Loyang Industrial Estate Singapore 508769,

hereinafter referred to as "the Assignee" of the other part.

WHEREAS:

A) The Assignor is the applicant and entitled to the benefit of **PCT Patent Application PCT/SG00/00029** (hereinafter referred to as "the Patent Application").

B) The parties hereto have agreed that the Patent Application should be transferred by the Assignor to the Assignee on the terms hereinafter defined and for the consideration hereinafter set forth in all countries except Singapore and the US.

NOW THIS ASSIGNMENT WITNESSETH:

1. In consideration of the sum of US$1 now paid by the Assignee to the Assignor (the receipt whereof is hereby acknowledged), the Assignor hereby assigns absolutely to the Assignee free from encumbrances:

   (A) ALL of its right title and interest in and to the Patent Application and, as of the effective date hereinafter defined, all rights and powers arising or accrued therefrom to the intent that the grant of the patent shall be in the name of and vest in the Assignee;

   (B) the right to apply for prosecute and obtain patent or similar protection throughout the world in respect of the invention claimed in the Patent Application including the right to claim priority therefrom to the intent that the grant of any patent(s) or similar protection shall be in the name of and vest in the Assignee.

2. This Assignment is to have an effective date of **3 June 2002.**

3. The Assignor further covenants that at the request and cost of the Assignee, the Assignor shall:

(A) assist the prosecution of the Patent Application to grant and shall execute all documents and do all acts as may be necessary or proper to obtain the acceptance of the Patent Application and for procuring the grant of the patent; and

(B) execute all such documents and do all such acts as may reasonably be necessary or proper to secure the vesting in the Assignee of all rights assigned hereunder.

IN WITNESS whereof this Assignment has been executed by duly authorized representatives on behalf of the parties hereto.

Signed by
for and on behalf of **Trek Technology (Singapore) Pte Ltd**
in the presence of:-

Name: FOO Kok Wah
Designation: Director, Operations

Signed by
for and on behalf of **Trek 2000 International Ltd**
in the presence of:-

Name: FOO Kok Wah
Designation: Director, Operations

A Portable Data Storage Device

The invention relates to a portable data storage device, and in particular, a portable data storage device for a computer.

Conventional data storage devices generally fall into two categories. The first category is electronic, solid-state memory devices such as read only memory (ROM) and random access memory (RAM). These memory devices are generally fitted within the computer. They are not intended to be removable or portable so that they may be used on different computers, for example, to permit the transfer of data from one computer to another computer.

The second type of device is surface based data storage devices in which data is stored, typically, on the surface of a disk or tape. Examples of surface storage devices are magnetic disks and CD ROMs. Such data storage devices require a mechanical drive mechanism to be installed in or coupled to the computer to permit the data on the storage device to be read by the computer. In addition, such memory devices are limited by the surface area of the storage device, and the combination of the storage device and the drive mechanism for reading data from the storage device is generally bulky and/or delicate due to the moving parts that are required within the drive mechanism and/or storage device.

In accordance with the present invention, there is provided a portable data storage device comprising

a USB plug for coupling the portable data storage device directly to a USB socket on a computer,

an interface device coupled to the USB plug;

a memory control device; and

a non-volatile solid-state memory device operative to function as an alternative to a magnetic disk or CD-ROM; the memory control device being coupled between the interface device and the memory device to control the flow of data from the memory device to the USB plug.

An advantage of the invention is that by providing a portable data storage device comprising a coupling device with an interface device, memory control device and a non-volatile solid-state memory device, it is possible to provide a portable data storage device which may be coupled to a computer having a serial bus port and which does not include moving parts or require a mechanical drive mechanism to read the data from the data storage device.

Preferably, the non-volatile solid-state memory device may be a read/write memory device, such as a flash memory device

Preferably, where the memory device is a read/write memory device, the memory control device controls the flow of data to and from the memory device.

Typically, the data storage device further comprises a manually operated switch movable between a first position in which writing of data to the memory device is enabled, and a second position in which writing of data to the memory device is prevented.

Preferably, the memory control device may include a read only memory which stores a program to control the operation of the memory control device. Preferably, the memory control device is a micro-controller.

Typically, the interface device comprises a universal serial bus (USB) driver to convert data between a USB format and a PC format, and the coupling device comprises a USB coupling device.

An example of a data storage device in accordance with the invention will now be described to the accompanying drawings, in which:

Figure 1 is a schematic block diagram of a portable data storage device;

Figure 2 is a flow diagram showing the initial setup of the data storage device by a software supplier;

Figure 3 is a flow diagram showing the initial setup of the data storage device by an end user; and

Figures 4a & 4b provide a flow diagram showing operation of the data storage device.

Figure 1 shows a data storage device 10 which includes a USB plug 1 which is coupled to a USB interface device 2. The USB interface device 2 is coupled to a micro-controller 3 which is coupled to a flash memory 4. The micro-controller

3 includes a read only memory (ROM) 5 which stores a program to control the operation of the micro-controller 3.

The operations performed by the micro-controller 3 include comparing passwords entered by a user with a corresponding password stored in the flash memory 4 to determine whether the user is authorised to access the contents of the flash memory 4. The program stored in the ROM 5 also controls the data flow to and from the flash memory 4 and can also detect whether the computer to which the memory device 1 is coupled has installed software programs which correspond to passwords stored in the flash memory 4. The micro-controller 3 can automatically retrieve passwords from the installed software to compare with passwords stored in the flash memory to verify that a user of the computer is authorised to access and run the software In addition, the program stored in the ROM 5 also permits the setting of a password in the flash memory by a software supplier to correspond to the password contained in software supplied to a user. Typically, the password may correspond to the serial number of the software.

The flash memory 4 is typically divided into a number of different sections or zones. Typically, the flash memory is divided into two zones and each zone has a unique password. If the data storage device 10 is supplied with packaged software, the software serial number can be set in one zone to be the password to permit a user to access and use the software. The other zone, which can be used typically for storing a user's data, may have a separate password which is set by the user. Typically, the passwords are stored in a secure location of the flash

flash memory in an encrypted form. The encryption, decryption, data flow control and USB protocol are all managed by the micro-controller 3.

The micro-controller 3 also includes a random access memory (RAM) 6 which is a temporary storage area to permit functioning of the micro-controller 3. In addition, a manual switch 7 is coupled between the flash memory 4 and the micro-controller 3 The manual switch 7 is movable between a first position in which a user may write data to the flash memory 4 and a second position in which data is prevented from being written to the flash memory 4

The device 10 also includes a USB socket 8 that is coupled directly to the USB plug 1 and permits other USB devices to be coupled to the USB via the device 10 For example, if a user wishes to increase memory space, a USB plug 1 of a second memory device 10 may be connected to the USB socket 8

Figure 2 is a flow diagram showing the set up procedure for the device 10 for a software supplier when the software supplier intends to supply the device as an authentication device for the software. Firstly, the plug 1 of the device 10 is plugged into 20 to a USB socket on a computer. After the device 10 has been plugged into the USB socket on the computer, a communication is established 21 between the computer and the device 10. The software supplier has pre-installed installation software on the computer which is run by the operator. From the pre-installed software, the operator selects password set up installation 22, in response to which the pre-installed software requests the operator to enter a password or serial number corresponding to the software

with which the device 10 is to be supplied The password or serial number is then encrypted 26 and stored 27 in the flash memory 4

Figure 3 is a flow diagram showing the initial set-up of a password for zone 2 of the flash memory 4 by an end user The device 10 is typically supplied with driver software that is loaded by the user onto the computer prior to set-up of the device. To set-up the password for zone 2 the user plugs in 20 the device 10 into a USB port on the computer and communication 21 is established between the computer and the device 10 The user then runs the driver software and the driver software enters a password installation set-up mode 23 for zone 2 The user then enters 28 a password that they wish to use to prevent unauthorised access to zone 2 of the flash memory 4 The password entered is then encrypted 29 and stored 30 in the flash memory 4

After an end user has performed the initial password set up procedure described above and shown in Figure 3, when a user plugs in 20 the device 10 to a USB port on a computer, the computer will establish a communication 21 with the device 10 and firstly, checks 33 an installation status flag stored in the flash memory 4 (see Figure 4). If the status flag is "Y", the device 10 outputs 34 an "OK" flag to the computer. The micro-controller 3 the instructs the computer to issue a request 35 to the user to select the zone they wish to enter If the status flag is "N", the device does not output an "OK" flag to the computer, and goes straight to step 35 In response to the request 35 for zone selection, the user selects 36 either zone 1 or zone 2.

If zone 1 is selected, the device 10 assumes that the user wishes to install software on the computer which is stored in the flash memory 4 and requests 37 the appropriate password for confirmation that the user is authorised to install the software. The micro-controller 3 receives the password entered by the user, retrieves the zone 1 password stored in the flash memory 4, decrypts the zone 1 password and compares it with the password entered by the user to authenticate 38 whether the user is authorised to install the software. If the passwords do not match, the device 10 prompts the computer to request 37 the user to enter the password again

If the password entered by the user matches the password stored in the flash memory 4, the micro-controller 3 starts 39 the software installation from the flash memory 4 to the computer. In order to install software, the computer sends 40 a read/write command in USB format to the micro-controller 3 for data, the micro-controller 3 retrieves the requested data from the flash memory 4 and sends 41 the data to the driver 2. The driver 2 converts 42 the data to PC format and outputs the data to the computer through the USB plug 1. The micro-controller 3 then checks 43 whether the software installation is complete. If the operation is not complete, the operation returns to step 40. If the installation of the software is complete, the status flag stored in the flash memory 4 is changed to "Y" and the device 10 may then be removed 45 from the USB socket on the computer.

If a user selects zone 2, the micro-controller 3 sends a command to the computer to request 46 the user to enter the password for zone 2. When the

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user enters the password, the computer sends the password to the micro-controller 3. The micro-controller 3 retrieves the password for zone 2 from the flash memory 4, decrypts 47 the password and compares it with the password entered by the user. If the password entered by the user is incorrect, the operation returns to step 46 and the computer requests 46 the user for the password again.

If the password entered by the user is correct, the user has access to zone 2 of the flash memory 4 to read data from the flash memory 4 and to write data to the flash memory 4 However, data can only be written to the flash memory 4 if the manual switch 7 is in the position to permit data to be written to the flash memory 4. In order to read or write data from or to the flash memory 4 a read or write command is sent 48 by the computer in USB format to the micro-controller 3. In response to the read or write command the micro-controller 3 either retrieves 49 data from the flash memory 4 and sends it to the driver 2 for conversion 50 to PC format and then to be output to the computer or receives data from the driver to write it to the flash memory 4.

The micro-controller 3 then determines 51 whether the read or write operation is complete. If the operation is not complete it returns to step 48. If the operation is complete the operation terminates 52.

The device 10 described above is for coupling to a universal serial bus (USB).

An advantage of the device 10 described above is that it provides a portable data storage device for a computer which does not require a mechanical operated reading/writing device. In addition, the device 10 has no moving parts. This enables to data storage device 10 to be more compact than conventional portable data storage devices.

Unless the context clearly requires otherwise, throughout the description and the claims, the words "comprise", "comprising", and the like, are to be construed in an inclusive sense as opposed to an exclusive or exhaustive sense, that is to say, in the sense of "including, but not limited to"

10

CLAIMS

1. A portable data storage device which comprises:

a USB plug for coupling the portable data storage device directly to a USB socket on a computer;

an interface device coupled to the USB plug;

a memory control device; and

a non-volatile solid-state memory device operative to function as an alternative to a magnetic disk or CD-ROM; the memory control device being coupled between the interface device and the memory device to control the flow of data from the memory device to the USB plug.

2. A portable storage device according to claim 1 in which the memory control device is operative to receive a password and compare it with a corresponding password stored in the memory device to determine whether access to the contents of the memory device is authorized.

3. A device according to claim 1 or 2, wherein the non-volatile solid-state memory device is a read/write memory device.

4. A device according to claim 3, wherein the read/write memory device is a flash memory device.

5 A device according to claim 3 or claim 4, wherein the memory control device controls the flow of data to and from the memory device.

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6. A device according to any of claims 3 to 5, further comprising a manually operated switch movable between a first position in which writing of data to the memory device is enabled, and a second position in which writing of data to the memory device is prevented

7. A device according to any of the preceding claims, wherein the memory control device comprises a micro-controller.

8. A portable data storage device substantially as herein described with reference to the accompanying drawings

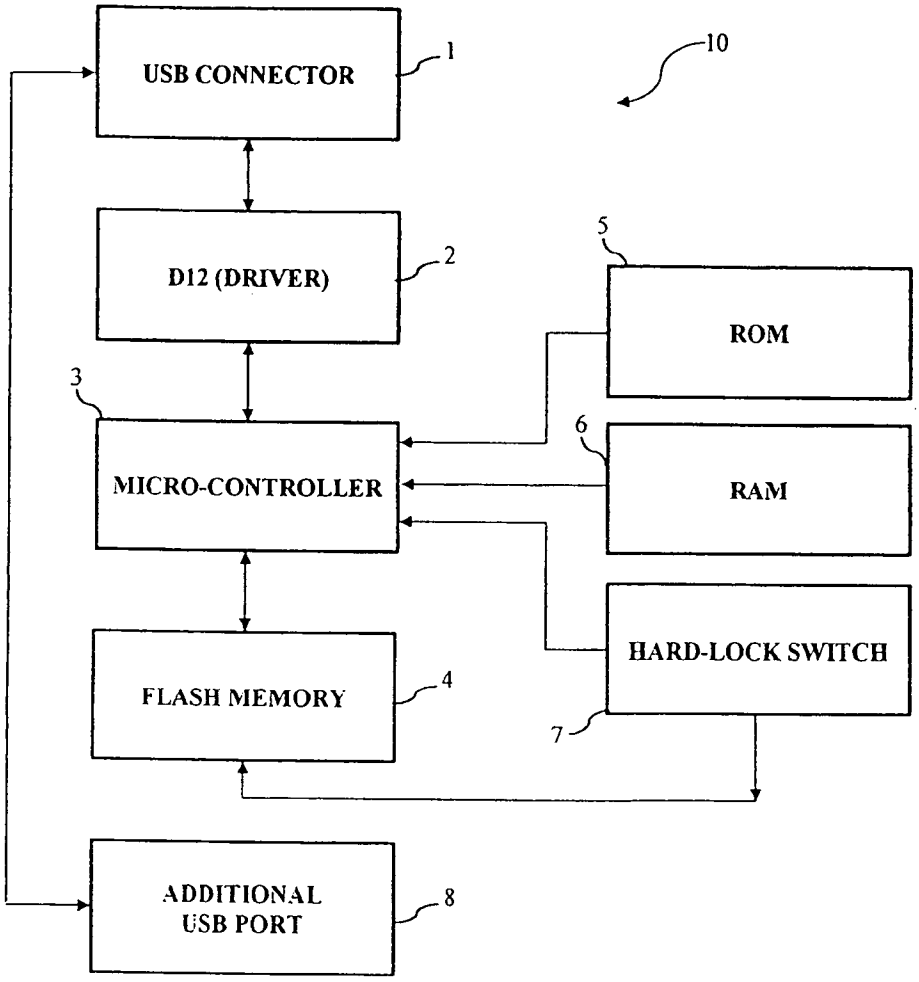
USB CONNECTOR
1
10
D12 (DRIVER)
2
5
ROM
3
MICRO-CONTROLLER
6
RAM
HARD-LOCK SWITCH
FLASH MEMORY
4
7
ADDITIONAL
USB PORT
8

Fig. 1

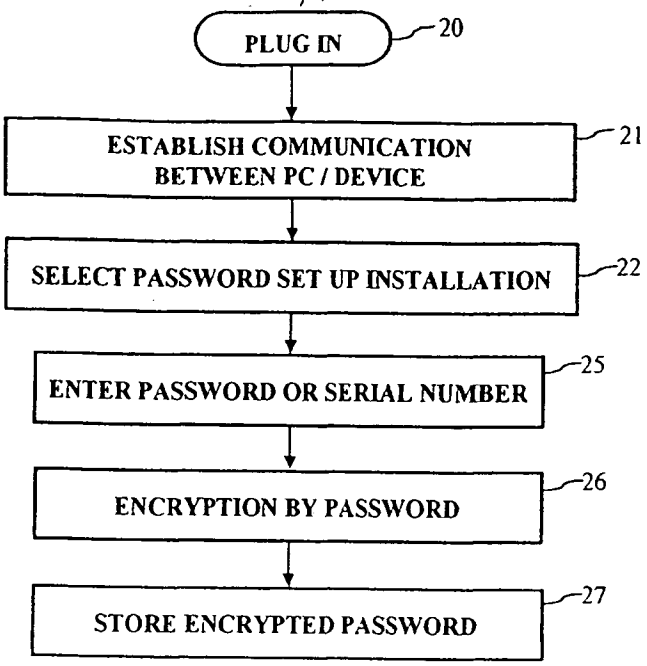
PLUG IN
20
ESTABLISH COMMUNICATION BETWEEN PC / DEVICE
21
SELECT PASSWORD SET UP INSTALLATION
22
ENTER PASSWORD OR SERIAL NUMBER
25
ENCRYPTION BY PASSWORD
26
STORE ENCRYPTED PASSWORD
27

Fig. 2.

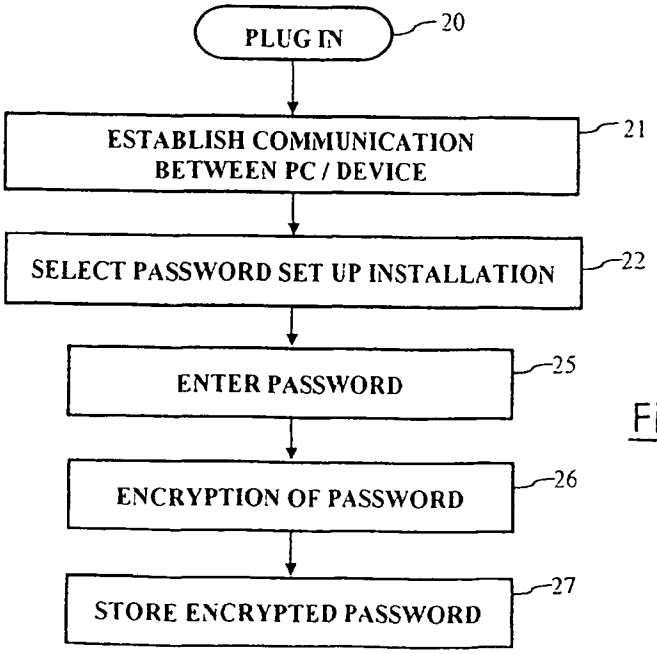
PLUG IN
20
ESTABLISH COMMUNICATION BETWEEN PC / DEVICE
21
SELECT PASSWORD SET UP INSTALLATION
22
ENTER PASSWORD
25
ENCRYPTION OF PASSWORD
26
STORE ENCRYPTED PASSWORD
27

Fig. 3.

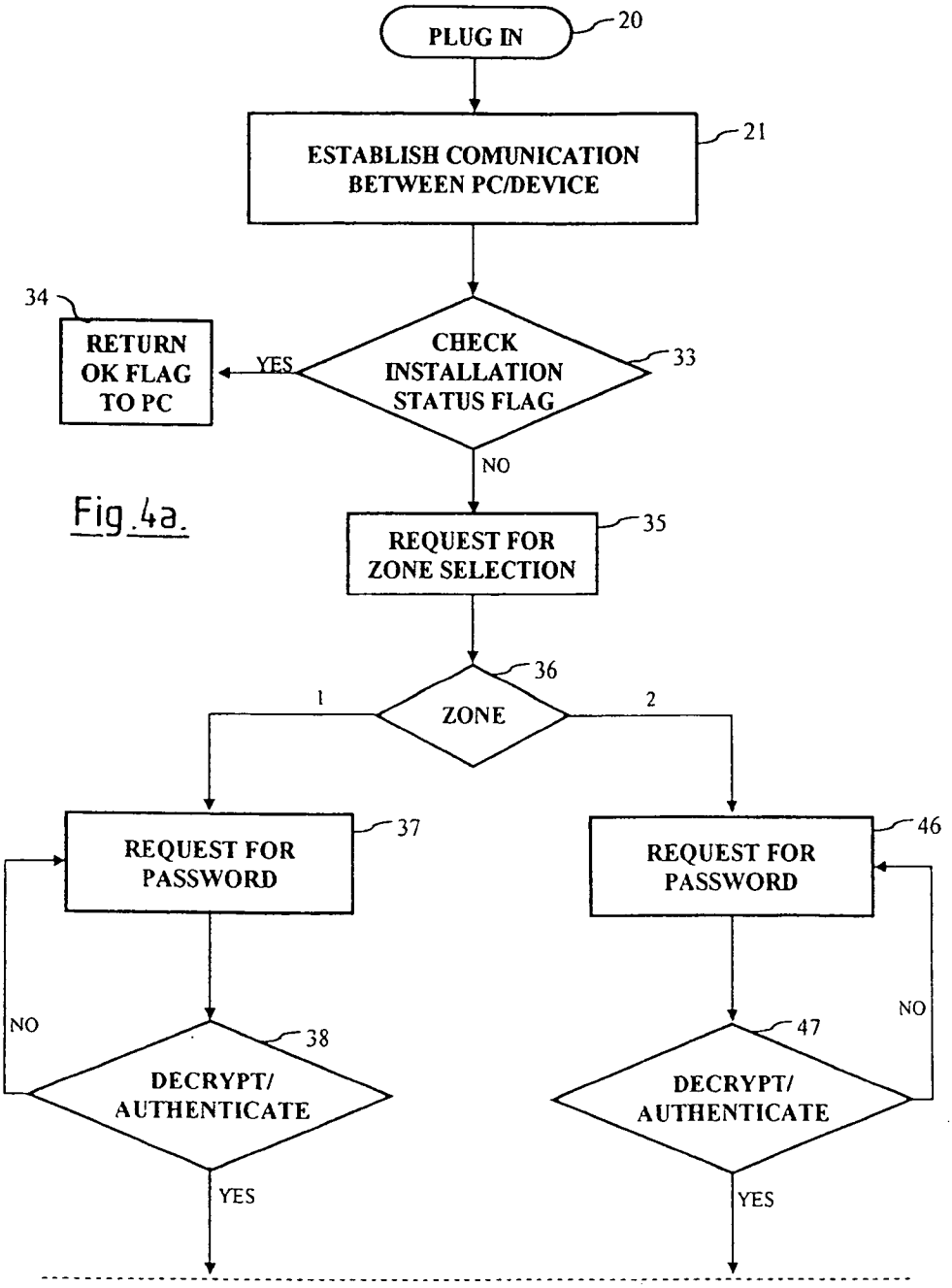
PLUG IN
20
ESTABLISH COMUNICATION BETWEEN PC/DEVICE
21
CHECK INSTALLATION STATUS FLAG
33
YES
RETURN OK FLAG TO PC
34
NO
REQUEST FOR ZONE SELECTION
35
ZONE
36
1
2
REQUEST FOR PASSWORD
37
DECRYPT/ AUTHENTICATE
38
NO
YES
REQUEST FOR PASSWORD
46
DECRYPT/ AUTHENTICATE
47
NO
YES

Fig.4a.

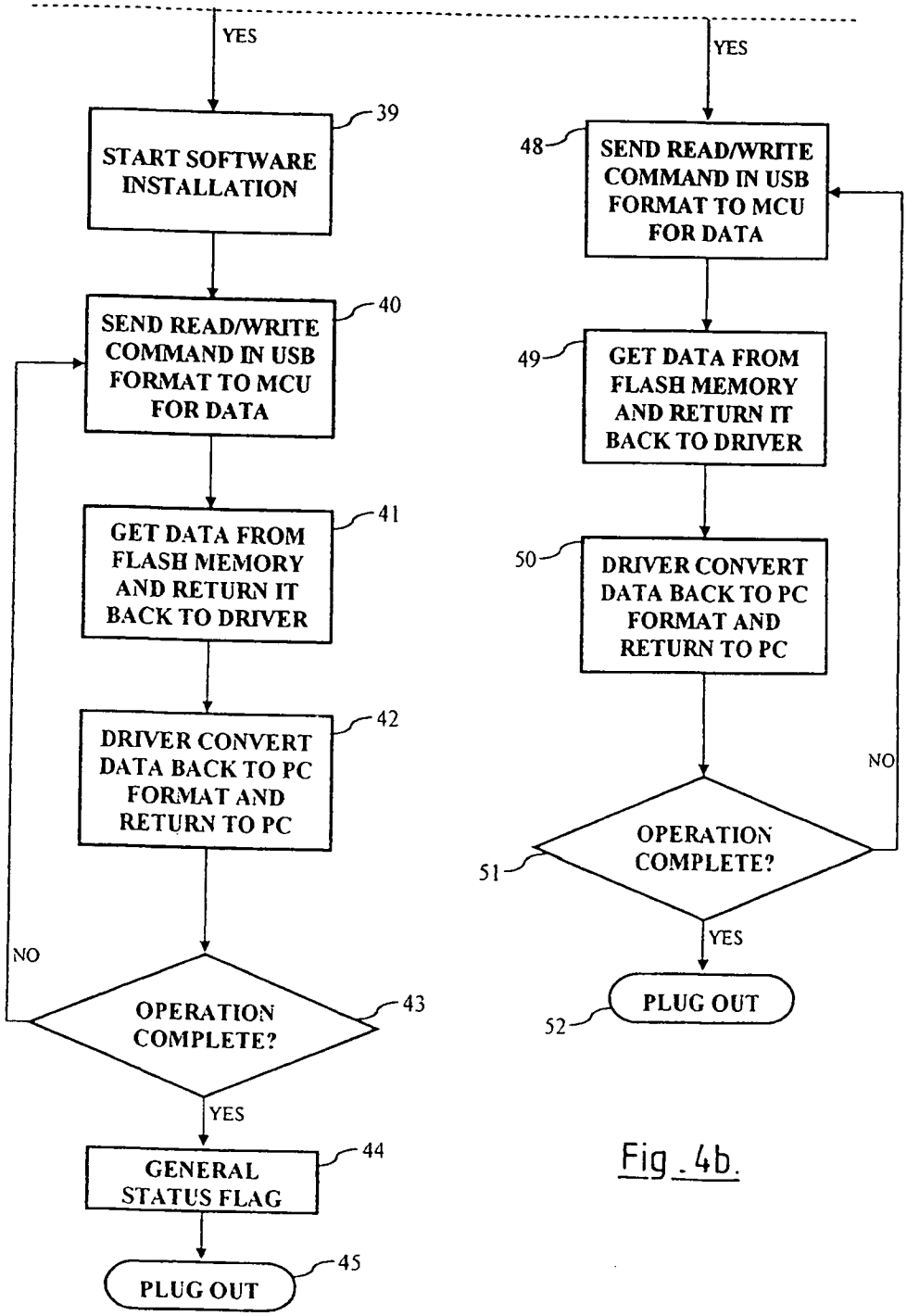
YES
START SOFTWARE INSTALLATION
39
SEND READ/WRITE COMMAND IN USB FORMAT TO MCU FOR DATA
40
GET DATA FROM FLASH MEMORY AND RETURN IT BACK TO DRIVER
41
DRIVER CONVERT DATA BACK TO PC FORMAT AND RETURN TO PC
42
NO
OPERATION COMPLETE?
43
YES
GENERAL STATUS FLAG
44
PLUG OUT
45
YES
48
SEND READ/WRITE COMMAND IN USB FORMAT TO MCU FOR DATA
49
GET DATA FROM FLASH MEMORY AND RETURN IT BACK TO DRIVER
50
DRIVER CONVERT DATA BACK TO PC FORMAT AND RETURN TO PC
NO
OPERATION COMPLETE?
51
YES
PLUG OUT
52

Fig. 4b.

FR1567

Patents Form No. 6

Our Ref: MH503885

Patents Act 1953

DECLARATION AS TO INVENTORSHIP [SECTION 10(5)]

We, **TREK 2000 INTERNATIONAL LIMITED**, of 30 Loyang Way, #07-13/14/15, Loyang Industrial Estate 460044, Singapore, Singapore hereby declare that the true and first inventors of the invention disclosed in the complete specification filed in pursuance of our application number 518169 dated 21 February 2000 are TENG PIN POO of Apt Blk 44, Bedok South Road, #11-763 460044, Singapore, a citizen of Malaysia and CHONG SENG CHENG of 129 Loyang Rise, Singapore 507472, Singapore, a citizen of Singapore and that our right for a patent for the invention is as follows:

By an Employment Contract and Assignment.

TREK 2000 INTERNATIONAL LIMITED

LAI Chee Kong
Chief Financial Officer

TO: The Commissioner of Patents
LOWER HUTT

PT0635623

IP Australia
PATENTS - TRADE MARKS - DESIGNS

112

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Internet http://www.ipaustralia.gov.au
ABN 38 113 072 755

14/04/03

TO: CULLEN & CO
GPO Box 1074
BRISBANE QLD 4001

NOTICE OF ACCEPTANCE

Re: Patent Application No. 33413 / 00 in the name of:
Trek Technology (Singapore) Pte Ltd

Your Reference: 02366AU/RH

The examiner has reported no objections to the application and complete specification as amended by the following alterations:

Item number(s) Specification 1-2
Application
Drawings

The application and complete specification were accepted on 01/04/03 and a notice of the acceptance will appear in the Official Journal of Patents on 29/05/03 under serial number 761064

All future correspondence should refer to this serial number.

Your patent will be sealed as soon as practicable after the 3 month period for opposition has expired.

You are reminded that, except where your application has undergone modified examination, you are required under subsection 45(3) to inform the Commissioner of the results of any searches carried out prior to the grant of the patent.

Enclosed for your information, are details of the application data at acceptance. This data will be the basis for any Deed that may later be issued. At present there is no provision under the Patents Act to reissue Deeds. It is, therefore, important that you notify this office of any changes before the opposition period expires.

Maria LEWIS
Patent Notification
Ext. 2020

AUSTRALIA

Patents Act 1990

IN THE MATTER of Patent Application No 33413/00 by Trek Technology (Singapore) Pte Ltd

STATEMENT OF PROPOSED AMENDMENTS UNDER SECTION 104

1. **Pages 1-3**
   Delete pages 1-3 currently on file and replace with substitute pages 1-3 submitted herewith.

2. **Pages 8-11**
   Delete pages 8-11 currently on file and replace with substitute pages 8-11 submitted herewith.

Trek Technology (Singapore) Pte Ltd
By the patent attorneys for the applicant
CULLEN & CO.

Registered Patent Attorney

To: The Commissioner of Patents,
Date: 31 December 2002

1

A Portable Data Storage Device

Field of the Invention

The invention relates to a portable data storage device, and in particular, a portable data storage device for a computer.

Background of the Invention

Conventional data storage devices generally fall into two categories. The first category is electronic, solid-state memory devices such as read only memory (ROM) and random access memory (RAM). These memory devices are generally fitted within the computer. They are not intended to be removable or portable so that they may be used on different computers, for example, to permit the transfer of data from one computer to another computer.

The second type of device is surface based data storage devices in which data is stored, typically, on the surface of a disk or tape. Examples of surface storage devices are magnetic disks and CD ROMs. Such data storage devices require a mechanical drive mechanism to be installed in or coupled to the computer to permit the data on the storage device to be read by the computer. In addition, such memory devices are limited by the surface area of the storage device, and the combination of the storage device and the drive mechanism for reading data from the storage device is generally bulky and/or delicate due to the moving parts that are required within the drive mechanism and/or storage device.

Summary of the Invention

In accordance with the present invention, there is provided a portable data storage device which comprises:

a USB plug for coupling the portable data storage device directly to a USB socket on a computer,

an interface device coupled to the USB plug,

a memory control device; and

a non-volatile solid-state memory device operative to function as an alternative to a magnetic disk or CD-ROM;

the memory control device being coupled between the interface device and the memory device to control the flow of data from the memory device to the USB plug.

An advantage of the invention is that by providing a portable data storage device comprising a coupling device with an interface device, memory control device and a non-volatile solid-state memory device, it is possible to provide a portable data storage device which may be coupled to a computer having a serial bus port and which does not include moving parts or require a mechanical drive mechanism to read the data from the data storage device.

Preferably, the non-volatile solid-state memory device may be a read/write memory device, such as a flash memory device.

Preferably, where the memory device is a read/write memory device, the memory control device controls the flow of data to and from the memory device.

Typically, the data storage device further comprises a manually operated switch movable between a first position in which writing of data to the memory device

is enabled, and a second position in which writing of data to the memory device is prevented.

Preferably, the memory control device may include a read only memory which stores a program to control the operation of the memory control device. Preferably, the memory control device is a micro-controller.

An example of a data storage device in accordance with the invention will now be described to the accompanying drawings, in which:

Brief Description of the Drawings

Figure 1 is a schematic block diagram of a portable data storage device;

Figure 2 is a flow diagram showing the initial setup of the data storage device by a software supplier;

Figure 3 is a flow diagram showing the initial setup of the data storage device by an end user; and

Figure 4 is a flow diagram showing operation of the data storage device.

Detailed Description of the Preferred Embodiments

Figure 1 shows a data storage device 10 which includes a USB plug 1 which is coupled to a USB interface device 2. The USB interface device 2 is coupled to a micro-controller 3 which is coupled to a flash memory 4. The micro-controller

3 includes a read only memory (ROM) 5 which stores a program to control the operation of the micro-controller 3.

The operations performed by the micro-controller 3 include comparing passwords entered by a user with a corresponding password stored in the flash memory 4 to determine whether the user is authorised to access the contents of the flash memory 4. The program stored in the ROM 5 also controls the data flow to and from the flash memory 4 and can also detect whether the computer to which the memory device 1 is coupled has installed software programs which correspond to passwords stored in the flash memory 4. The micro-controller 3 can automatically retrieve passwords from the installed software to compare with passwords stored in the flash memory to verify that a user of the computer is authorised to access and run the software. In addition, the program stored in the ROM 5 also permits the setting of a password in the flash memory by a software supplier to correspond to the password contained in software supplied to a user. Typically, the password may correspond to the serial number of the software.

The flash memory 4 is typically divided into a number of different sections or zones. Typically, the flash memory is divided into two zones and each zone has a unique password. If the data storage device 10 is supplied with packaged software, the software serial number can be set in one zone to be the password to permit a user to access and use the software. The other zone, which can be used typically for storing a user's data, may have a separate password which is set by the user. Typically, the passwords are stored in a secure location of the

flash memory in an encrypted form. The encryption, decryption, data flow control and USB protocol are all managed by the micro-controller 3.

The micro-controller 3 also includes a random access memory (RAM) 6 which is a temporary storage area to permit functioning of the micro-controller 3. In addition, a manual switch 7 is coupled between the flash memory 4 and the micro-controller 3. The manual switch 7 is movable between a first position in which a user may write data to the flash memory 4 and a second position in which data is prevented from being written to the flash memory 4.

The device 10 also includes a USB socket 8 that is coupled directly to the USB plug 1 and permits other USB devices to be coupled to the USB via the device 10. For example, if a user wishes to increase memory space, a USB plug 1 of a second memory device 10 may be connected to the USB socket 8.

Figure 2 is a flow diagram showing the set up procedure for the device 10 for a software supplier when the software supplier intends to supply the device as an authentication device for the software. Firstly, the plug 1 of the device 10 is plugged into 20 to a USB socket on a computer. After the device 10 has been plugged into the USB socket on the computer, a communication is established 21 between the computer and the device 10. The software supplier has pre-installed installation software on the computer which is run by the operator. From the pre-installed software, the operator selects password set up installation 22, in response to which the pre-installed software requests the operator to enter a password or serial number corresponding to the software

with which the device 10 is to be supplied. The password or serial number is then encrypted 26 and stored 27 in the flash memory 4.

Figure 3 is a flow diagram showing the initial set-up of a password for zone 2 of the flash memory 4 by an end user. The device 10 is typically supplied with driver software that is loaded by the user onto the computer prior to set-up of the device. To set-up the password for zone 2 the user plugs in 20 the device 10 into a USB port on the computer and communication 21 is established between the computer and the device 10. The user then runs the driver software and the driver software enters a password installation set-up mode 23 for zone 2. The user then enters 28 a password that they wish to use to prevent unauthorised access to zone 2 of the flash memory 4. The password entered is then encrypted 29 and stored 30 in the flash memory 4.

After an end user has performed the initial password set up procedure described above and shown in Figure 3, when a user plugs in 20 the device 10 to a USB port on a computer, the computer will establish a communication 21 with the device 10 and firstly, checks 33 an installation status flag stored in the flash memory 4 (see Figure 4). If the status flag is "Y", the device 10 outputs 34 an "OK" flag to the computer. The micro-controller 3 the instructs the computer to issue a request 35 to the user to select the zone they wish to enter. If the status flag is "N", the device does not output an "OK" flag to the computer, and goes straight to step 35. In response to the request 35 for zone selection, the user selects 36 either zone 1 or zone 2.

If zone 1 is selected, the device 10 assumes that the user wishes to install software on the computer which is stored in the flash memory 4 and requests 37 the appropriate password for confirmation that the user is authorised to install the software. The micro-controller 3 receives the password entered by the user, retrieves the zone 1 password stored in the flash memory 4, decrypts the zone 1 password and compares it with the password entered by the user to authenticate 38 whether the user is authorised to install the software. If the passwords do not match, the device 10 prompts the computer to request 37 the user to enter the password again.

If the password entered by the user matches the password stored in the flash memory 4, the micro-controller 3 starts 39 the software installation from the flash memory 4 to the computer. In order to install software, the computer sends 40 a read/write command in USB format to the micro-controller 3 for data, the micro-controller 3 retrieves the requested data from the flash memory 4 and sends 41 the data to the driver 2. The driver 2 converts 42 the data to PC format and outputs the data to the computer through the USB plug 1. The micro-controller 3 then checks 43 whether the software installation is complete. If the operation is not complete, the operation returns to step 40. If the installation of the software is complete, the status flag stored in the flash memory 4 is changed to "Y" and the device 10 may then be removed 45 from the USB socket on the computer.

If a user selects zone 2, the micro-controller 3 sends a command to the computer to request 46 the user to enter the password for zone 2. When the

user enters the password, the computer sends the password to the micro-controller 3. The micro-controller 3 retrieves the password for zone 2 from the flash memory 4, decrypts 47 the password and compares it with the password entered by the user. If the password entered by the user is incorrect, the operation returns to step 46 and the computer requests 46 the user for the password again.

If the password entered by the user is correct, the user has access to zone 2 of the flash memory 4 to read data from the flash memory 4 and to write data to the flash memory 4. However, data can only be written to the flash memory 4 if the manual switch 7 is in the position to permit data to be written to the flash memory 4. In order to read or write data from or to the flash memory 4 a read or write command is sent 48 by the computer in USB format to the micro-controller 3. In response to the read or write command the micro-controller 3 either retrieves 49 data from the flash memory 4 and sends it to the driver 2 for conversion 50 to PC format and then to be output to the computer or receives data from the driver to write it to the flash memory 4.

The micro-controller 3 then determines 51 whether the read or write operation is complete. If the operation is not complete it returns to step 48. If the operation is complete the operation terminates 52.

An advantage of the device 10 described above is that it provides a portable data storage device for a computer which does not require a mechanical operated reading/writing device. In addition, the device 10 has no moving parts.

This enables to data storage device 10 to be more compact than conventional portable data storage devices.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A portable data storage device which comprises:

a USB plug for coupling the portable data storage device directly to a USB socket on a computer,

an interface device coupled to the USB plug,

a memory control device; and

a non-volatile solid-state memory device operative to function as an alternative to a magnetic disk or CD-ROM;

the memory control device being coupled between the interface device and the memory device to control the flow of data from the memory device to the USB plug.

2. A portable storage device according to claim 1 in which the memory control device is operative to receive a password and compare it with a corresponding password stored in the memory device to determine whether access to the contents of the memory device is authorised.

3. A device according to claim 1 or claim 2, wherein the non-volatile solid-state memory device is a read/write memory device.

4. A device according to claim 3, wherein the read/write memory device is a flash memory device.

5. A device according to claim 3 or claim 4, wherein the memory control device controls the flow of data to and from the memory device.

6. A device according to any of claims 3 to 5, further comprising a manually operated switch movable between a first position in which writing of data to the memory device is enabled, and a second position in which writing of data to the memory device is prevented.

7. A device according to claims 1-6, wherein the memory control device comprises a micro-controller.

Dated this 31st Day of December 2002
Trek Technology (Singapore) Pte Ltd
By their Patent Attorneys
CULLEN & CO

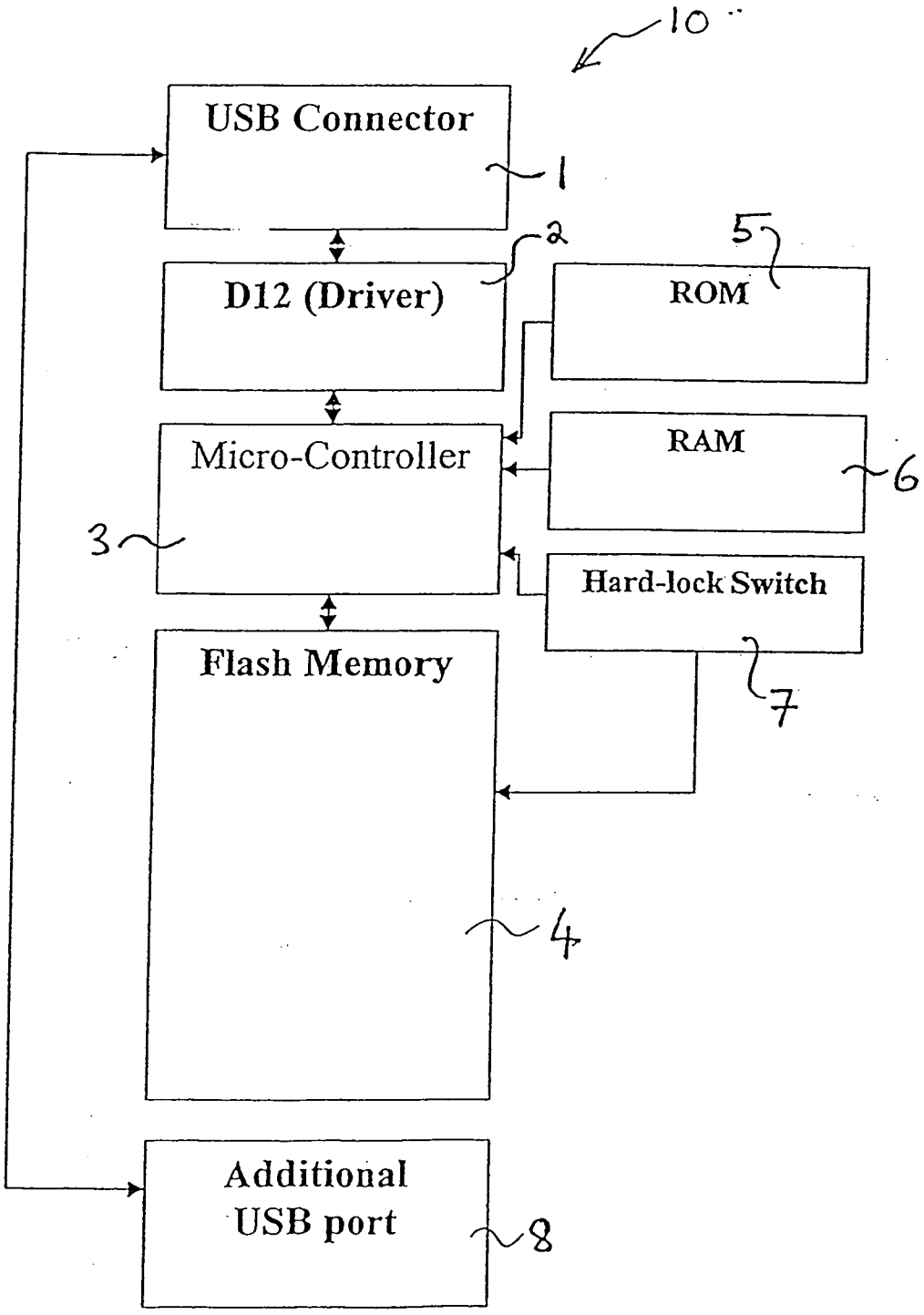

10
USB Connector
1
2
D12 (Driver)
5
ROM
Micro-Controller
RAM
6
3
Hard-lock Switch
7
Flash Memory
4
Additional
USB port
8

Figure 1

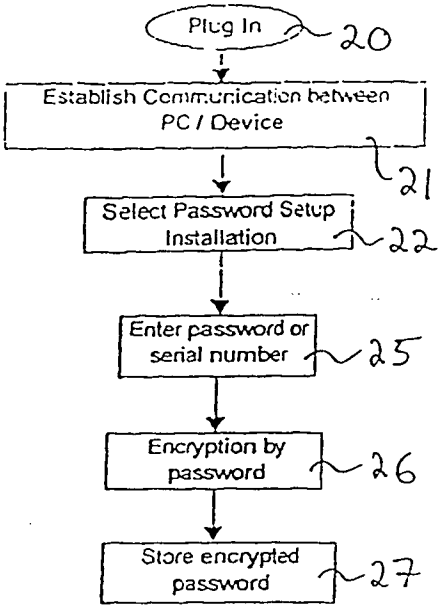


Figure 2

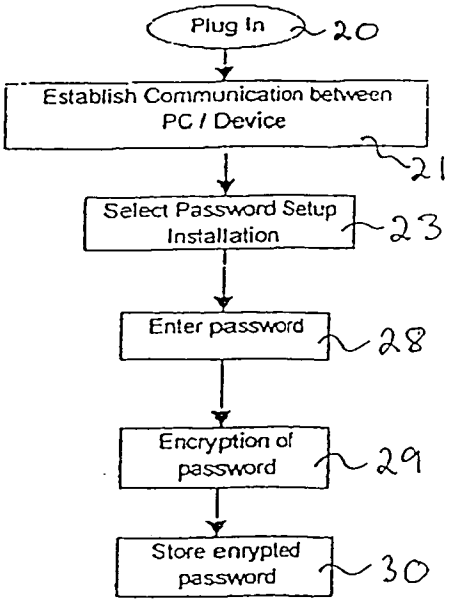


Figure 3

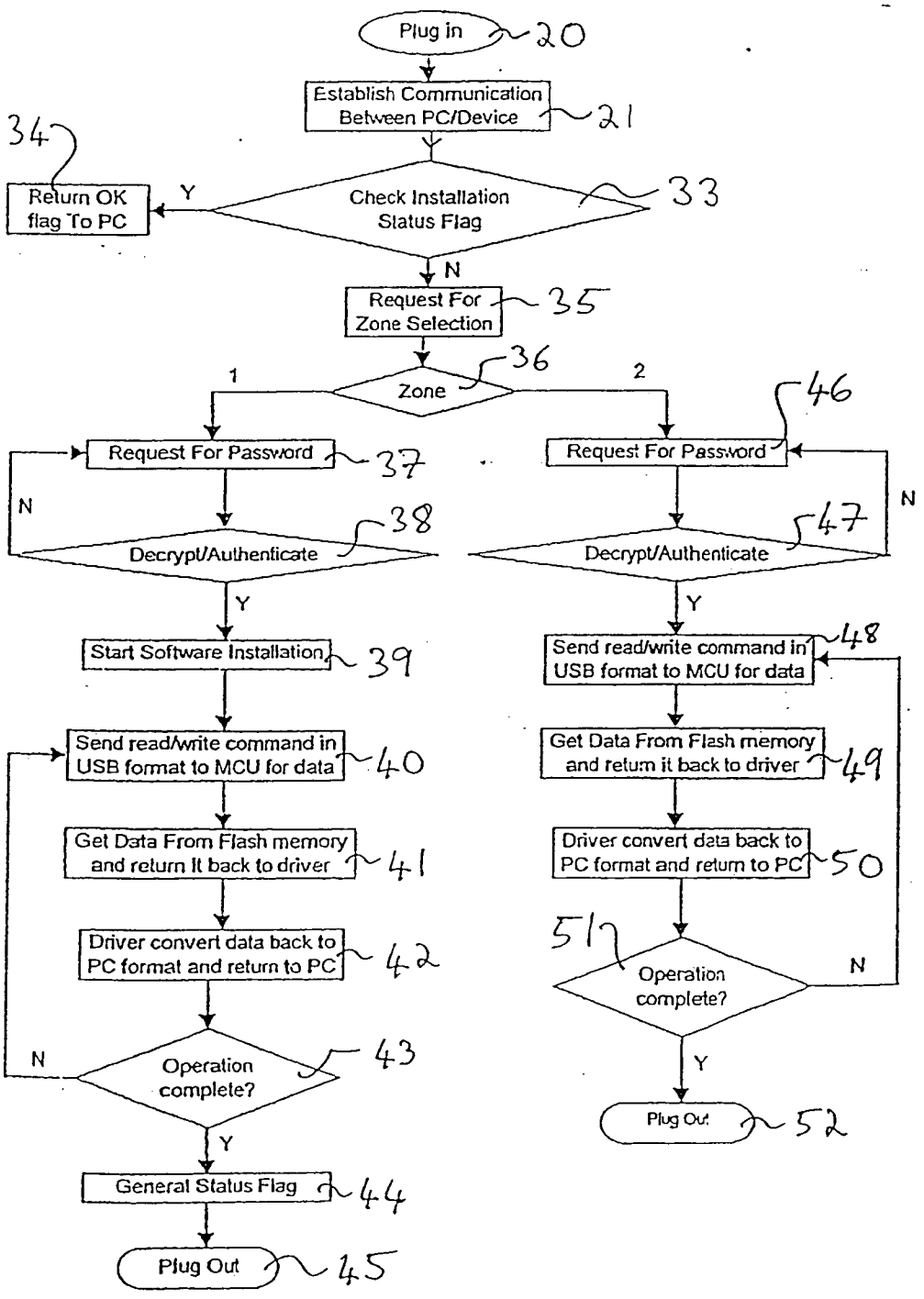

Plug in
20
Establish Communication Between PC/Device
21
34
Return OK flag To PC
Y
Check Installation Status Flag
33
N
Request For Zone Selection
35
1
Zone
36
2
46
Request For Password
37
Request For Password
N
38
Decrypt/Authenticate
47
Decrypt/Authenticate
N
Y
Y
Start Software Installation
39
Send read/write command in USB format to MCU for data
48
Send read/write command in USB format to MCU for data
40
Get Data From Flash memory and return it back to driver
49
Get Data From Flash memory and return It back to driver
41
Driver convert data back to PC format and return to PC
50
Driver convert data back to PC format and return to PC
42
51
Operation complete?
N
43
N
Operation complete?
Y
Y
General Status Flag
44
Plug Out
52
Plug Out
45

Figure 4

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No.	:	09/803,173	Confirmation No.: 9334
Applicant	:	Chong Seng Cheng	
Filed	:	March 9, 2001	
TC/A.U.	:	2186	
Examiner	:	Choi, Woo H.	
Docket No.	:	1601457-0004	
Customer No.	:	007470	

AFFIDAVIT OF YONGMIN KIM
UNDER 37 CFR 1.132

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

I, Yongmin Kim, Ph.D., of 4431 NE 189th Place, Seattle, WA 98155 do solemnly affirm and say as follows:

1. I, Yongmin Kim, am authorized by Trek 2000 International Ltd. ("Trek"), which is the assignee of record of the above-captioned patent application, to make this affidavit on its behalf. Unless stated otherwise, the matters discussed in this affidavit, which I believe to be true, are within my own knowledge and/or derived from the records of these proceedings to which I have ready access.

2. My credentials are set forth in my Curriculum Vitae, attached hereto as Exhibit **YK-1**. In summary, I have been teaching, working and researching in the fields of electrical engineering and computer engineering for more than 25 years. I have obtained bachelor's degree in electronics engineering from Seoul National University in Seoul, Korea in 1975, and master's and doctorate degrees in electrical engineering from the University of Wisconsin-Madison in 1979 and 1982, respectively.

3. I am currently a Professor in the Department of Electrical Engineering and Professor and Chair in the Department of Bioengineering at the University of Washington in Seattle. I am also an Adjunct Professor of Computer Science and Engineering. I have offered various lectures and courses to engineers and researchers around the world

including U.S., U.K., France, Italy, Korea, Singapore and Japan. My research interests include computer architectures, digital systems and subsystems and signal processing. I have supervised 29 Ph.D. dissertations and 101 Masters theses and am currently working with 15 Ph.D. students in addition to 2 professional research staff members. I have more than 40 patents issued and approximately 25 patents pending in the U.S. and abroad. I have transferred the invented technologies to industry with 23 licenses and helped with the commercialization of these technologies.

4. I have been a consultant to a number of governmental and commercial organizations, including U.S. government agencies, Intel, Siemens, Texas Instruments, Micron, Samsung, Hitachi, Fujitsu and Canon. I am a Fellow of the Institute of Electrical and Electronics Engineers (IEEE). I have authored or co-authored many books and have more than 370 research publications. I am on the Editorial Board of several journals, including the Proceedings of the IEEE. Among many honors, I have received the 1988 Early Career Achievement Award of the IEEE/EMBS and the 2003 Ho-Am Prize in Engineering. I am the President of the IEEE/EMBS in 2005 and 2006. In 2004, the University of Washington Board of Regents appointed me as the Hunter and Dorothy Simpson Endowed Chair.

5. I am retained by Trek as a consultant to assist in the prosecution of the present application by providing a background discussion on the technology and explaining certain aspects of the invention disclosed and claimed in the present application based on my expertise and knowledge in the subject matter. Below I briefly describe portable mass storage devices and the state of the prior art. I also identify where aspects of the invention are taught in the specification and point out the differences between the prior art and the claimed invention in the present application.

Background

6. The computer technology at issue in the present application centers on "mass storage devices." Specifically, the present application discloses a portable mass storage device that is an alternative to, and eliminates the shortcomings of, traditional mass storage devices such as magnetic disks or CD-ROMs. *See, e.g.*, page 1, line 13 to page 2, line 11; page 9, lines 5 – 9.

7. A mass storage device is a storage device having a very large storage capacity. *IEEE Standard Dictionary of Electrical and Electronics Terms*, page 630, attached hereto as

Exhibit **YK-2**. Mass storage devices are indispensable elements of a computer system. They allow the computer and the computer user to store and transfer between computers large amounts of data (e.g., documents, graphics, audio, pictures, video, software programs, etc.) The data may be retrieved from the mass storage for later use.

8. Each computer typically has more than one type of mass storage. Most computers today come with a hard drive. A hard drive is a permanent type of mass storage device because it is permanently contained inside the computer.

9. In addition to permanent mass storage devices such as hard drives, virtually every computer allows a user to store large amounts of data on portable mass storage devices. There are many types of portable mass storage devices – floppy disks, CD-ROMs, ZIP disks, flash memory, etc. Data stored on portable mass storage devices can be carried away from one computer and transported to another computer. In addition, data is frequently archived on portable mass storage devices to back up a computer's hard drive.

10. Each of the different types of portable memory storage devices discussed above is designed to work in conjunction with a specially designed reader or a specially designed slot into which it is inserted. This has resulted in a series of compromises of, among other things, the portability, universality, or ease of use of the devices. The portable mass storage device disclosed in the present application does not require the use of a separate drive, reader/writer or cable and does not need to be installed inside the computer. Rather, the present application teaches a self-contained mass storage device having a USB plug that directly plugged into the USB socket of a host computer. Thus, the disclosed invention avoids the disadvantages that plagued much of the prior art. *See, e.g.*, page 1, line 13 to page 2, line 11; page 9, lines 5 – 9.

11. I am advised that claim 22, as amended, recites as follows:

> A unitary portable data storage device which can be directly plugged into a universal serial bus (USB) socket of a computer and which is operative to function as an alternative to a magnetic disk or CD, and which is capable of storing software for installation to the computer or of receiving and storing user's data present in the computer, the unitary portable data storage device comprising:
>
> ***a USB plug integrated into the unitary portable data storage device without an intervening cable capable of coupling the unitary portable data storage device directly to a USB socket on a computer;***

a single interface, said interface allowing the unitary portable data storage device to communicate via the USB protocol and being coupled to the USB plug;

a non-volatile solid-state memory, ***said memory being non-removable from the unitary portable data storage device and having sufficient capacity to enable the unitary portable data storage device to serve as an alternative to a magnetic disk or CD***; and

a memory controller, ***the memory controller being coupled between the interface and the memory to control the flow of data between the memory and the USB plug in a manner to enable the unitary portable data storage device to operate as an alternative to a magnetic disk or CD***.

(Emphasis provided).

12. In my view, as explained in more detail below, the present application discloses a portable mass storage device that, among other things: (1) includes a USB plug integrated into the device without an intervening cable capable of coupling the device directly to a USB socket on a computer; (2) is of unitary construction; and (3) includes a non-volatile solid-state memory that is non-removable from the device. As presented above, these limitations are expressly recited in claim 22 of the present application. It is also my opinion that the cited references do not teach at least some of these claim limitations. Again, I provide my explanations below.

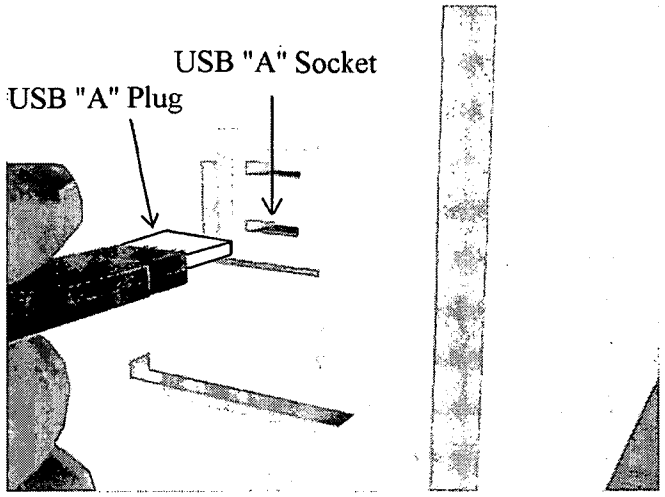
"Directly Without An Intervening Cable" Limitation

13. In my view, the specification as filed discloses the integrated plug of the USB device is directly plugged into a USB socket of a host computer. For example, on page 5, lines 18-19, the specification states that: "...the plug 1 of the device 10 is plugged into 20 to a USB socket on a computer."

14. In my opinion, in describing the structure of the portable mass storage device and how the device is connected to the host computer, the specification discloses the physical and electrical characteristics as well as compatibility of the device's integrated USB plug and the host computer's USB socket.

15. As mentioned above, the original specification clearly discloses that the claimed device 10 includes a USB plug 1, and that the host computer has a USB socket which the USB plug 1 of the device 10 plugs into.

16. It was well known in the art that host computers include a USB "A"-type socket as illustrated below. The USB Specification defines this. *See USB Specification Revision 1.1*, pages 73-74, attached hereto as Exhibit **YK-3**.



17. Consistent with the USB Specification and the teaching of the patent specification, I understand that USB plug 1 of the device would only be the type that is electrically and physically compatible with the host computer's USB "A"-type socket. This is called a USB "A"-type plug, as illustrated above. The physical and electrical characteristics of the USB "A" plug and the USB "A" socket are defined in the USB Specification.

18. When there is a USB "A" plug and a USB "A" socket, the intuitive and proper way to establish the connection between the two is by directly coupling the USB "A" plug to the USB "A" socket. The use of a cable between a USB "A" plug and a USB "A" socket is explicitly prohibited in the USB Specification. Thus, given the USB Specification and having read the specification of the present application, I clearly understand that the USB plug 1 of the disclosed device would directly connect to a USB socket of a host computer without any intervening cable.

19. The inventors' use of the D12 part in the Figure 1 in combination with the USB plug further supports my conclusion that the patent application discloses an integrated USB plug. D12 is a Philips part. D12 is used as the USB interface controller 2 in the device 10. Those skilled in the art at the time of the invention would understand that the D12 part was designed to be used on a printed circuit board in close proximity to the socket, as opposed to being connected to the socket via an intervening cable. (I should note that at the time of the invention, D12 would typically be proximately connected to a USB "B"-type socket rather than a USB "A"-type plug). I consider eliminating the need of the USB "B"-type socket and an intervening cable disclosed in the present application very innovative.

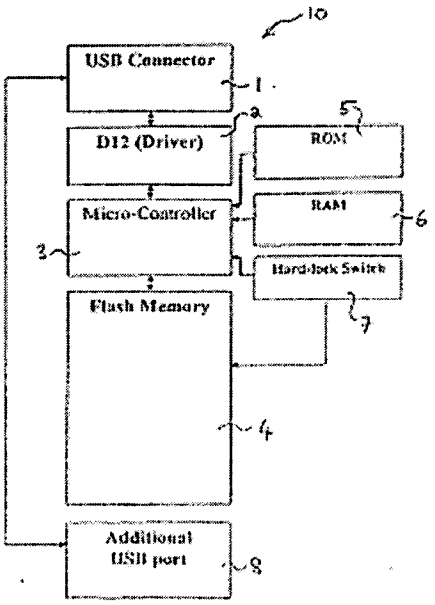
20. Therefore, it is my opinion that the patent specification as filed unambiguously discloses that the integrated USB plug of the storage device plugs directly into a USB socket on a computer.

"Unitary" and "Memory Being Non-Removable" Limitations

21. In my opinion, in describing and illustrating the structure and elements of the portable mass storage device (Figure 1) as well as the operation of the device, the original specification unambiguously teaches that the portable mass storage device described in the application is of unitary construction with an integrated USB plug and a non-volatile solid-state memory that is a fixed, non-removable element of the device.

22. In reading the present application, I note that the portable mass storage device 10 is consistently referred to as "a portable data storage device" or "the portable storage device" in the singular form. *See, e.g.,* page 1, lines 3 – 4, lines 24 – 25; page 2, lines 8 – 9; page 3, lines 12, 15 – 20 and 22; and page 4, lines 21.

23. Similarly, the elements of the portable mass storage device shown in Figure 1, reproduced below, are collectively referred to as the singular "device 10" throughout the specification.



24. Such description and illustration of the device highlights one of the innovative aspects of the invention — that the device is of unitary construction so it is easily portable and pluggable/removable from the host computer. This follows naturally from the

background discussion in the specification regarding the shortcomings of prior art mass storage devices and how the present invention eliminates those shortcomings.

25. In discussing the shortcomings of magnetic disks and CD-ROMs, the present application specifically points out that a separate drive mechanism is required in order to access the data on a magnetic disk or CD-ROM. The application also points out that as a surface-based storage device, a magnetic disk or CD-ROM is limited by its surface area. In other words, the storage capacity of a magnetic disk or CD-ROM is constrained by the size of the disk or CD-ROM. These characteristics of magnetic disks and CD-ROMs make them bulky, delicate and generally less than ideal in terms of portability. *See* page 1, lines 13 – 22.

26. In light of this background discussion, it is clear the present invention teaches a portable mass storage device of unitary construction with no removable part, including a fixed, non-removable non-volatile solid-state memory – as opposed to having a combination of a removable memory device and a drive mechanism as in the case of magnetic disks or CD-ROMs, where the disk or CD is routinely taken out of its drive so that it can be carried around to be used at a different drive on a different host computer.

27. Referring to Figure 1, reproduced above, the specification states: "Figure 1 shows a data storage device 10 which includes a USB plug 1 which is coupled to a USB interface device 2. The USB interface device 2 is coupled to a micro-controller 3 which is coupled to a flash memory 4." Page 3, lines 22 – 24. Having read the entirety of the specification, including Figure 1 and its corresponding description, I do not consider Figure 1 as disclosing a removable memory or a USB plug connected to the device by a cable. Rather, given that portable mass storage device 10 includes a USB plug 1, a USB interface device 2, a micro-controller 3 and a flash memory 4 coupled one after the other as described, it is clear to me that flash memory 4 is a flash memory chip fixedly installed (e.g., soldered to the circuit board) within the device 10 together with micro-controller 3 and USB interface device 2.

28. It is generally understood in the art that unlike certain types of memory chips that are intended to be removable from the device in which the chip is installed (for example, EPROMs can be removed so that its contents can be erased and re-programmed), flash memory chips are fixedly installed within a device and are non-removable under

normal use of the device. The present application does not teach otherwise. Thus, I understand the specification to teach a unitary portable mass storage device with a non-removable flash memory.

29. In addition to the above, I respectfully direct the Examiner's attention to the following disclosure in the specification: "[i]f the installation of the software is complete, ... *the device 10 may then be removed [] from the USB socket* on the computer" (emphasis provided). Page 7, lines 19 – 22. I note that these passages describe the device, rather than the plug, as being removed from the socket. If the specification had intended to teach a device that requires a cable to connect to the USB socket, it would not have spoken of plugging or removing the device itself into or from the socket. Instead, it would have said, "the plug 1 of the device 10 may then be removed." This further confirms that the unitary portable storage device disclosed in the original specification has an integrated USB plug, allowing the device to be plugged directly into the USB socket on a computer without an intervening cable.

30. As described above, the inventors' use of the Philips' D12 part further supports my opinion that one skilled in the art, reading the patent application, would understand that the invention discloses a device of unitary construction.

31. In sum, when read and understood in the context of the problems in prior art mass storage devices, how the present invention solves those problems and how the disclosed device operates, I find the specification as a whole clearly conveys to me that the portable mass storage device is of unitary construction, having a non-removable memory chip installed within it and a USB plug integrated into it without an intervening cable.

U.S. Patent No. 6,038,320 – The "*Miller*" Reference

32. I have reviewed the *Miller* reference. The device taught in *Miller* is neither designed to serve as a mass storage device, nor does it have the capability or capacity to do so. Rather, the *Miller* device is designed to limit access to a computer and store only a unique key code and an encrypted password, both of which are of limited size (e.g., *Miller* suggests that the password can be six bytes, *see* column 3, lines 42 – 43).

33. My review of the *Miller* reference indicates that the device disclosed in *Miller* does not have the requisite capability or capacity to be a mass storage device. *Miller* does not teach using a memory that has a large enough capacity for use in a mass storage

device. Instead, it teaches that its memory is used to store a key code or password of limited size. Similarly, *Miller* does not teach using a memory controller that can handle the data flow in a mass storage device. *Miller* also does not otherwise suggest that the device can be used to store a substantial amount of data. Therefore, I conclude that *Miller* fails to disclose at least the "memory having sufficient capacity" and "memory controller ... to control the flow of substantial amounts of data" claim limitations in claim 22 of the present application.

U.S. Patent No. 6,457,099 – The "*Gilbert*" Reference

34. I have reviewed the *Gilbert* reference and I am of the view that it does not disclose a unitary portable data storage device having a USB plug integrated into it without an intervening cable capable of coupling the unitary portable data storage device directly to a USB socket on a computer.

35. *Gilbert* teaches a programmable dedicated application card (PDAC) that executes dedicated software application(s) stored in the PDAC and sends the results to a user via a host computer to which the PDAC is connected. *See, e.g.,* column 1, lines 45 – 62. *Gilbert* teaches that using a dedicated RISC processor in the PDAC to run software improves execution speed. *Gilbert* also teaches that by running the software on the PDAC instead of on the host computer, resources of the host computer are freed up for other tasks, thereby improving the host's performance. *See, e.g.,* column 1, line 63 to column 2, line 7.

36. *Gilbert* further states that a PDAC is its own stand-alone computer system, and the use of a PDAC functions as a hardware accelerator and enhances the capabilities of the host computer system. *See, e.g.,* column 2, lines 33 – 36; column 3, lines 21 – 26.

37. However, *Gilbert* does not teach a USB plug integrated into a unitary device or a storage device as recited in claim 22 of the present application. I respectfully disagree that the cited portion of *Gilbert* (column 7, lines 11 – 30) discloses this claim limitation.

U.S. Patent No. 6,786,412 – The "*Kondo*" Reference

38. I have also reviewed *Kondo* and I am of the view that it does not disclose a unitary portable data storage device having a USB plug integrated into it without an intervening cable capable of coupling the unitary portable data storage device directly to a USB socket on a computer.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements are made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the present application or any patent issued thereon.

Respectfully submitted,

Dated: March 17, 2005

Yongmin Kim

January 26, 2005

CURRICULUM VITAE

PERSONAL

Name:	**Yongmin Kim**
Address:	Departments of Bioengineering and Electrical Engineering University of Washington Box 352500 Seattle, WA 98195-2500
Email Address:	ykim@u.washington.edu
Phone:	(206) 685-2271 and (206) 685-2002
Fax Number:	(206) 221-6837 and (206) 685-3300
Birthdate:	May 19, 1953
Marital Status:	Married, three children

EDUCATION

Ph.D.	Department of Electrical and Computer Engineering, University of Wisconsin-Madison, August 1982
M.S.	Department of Electrical and Computer Engineering, University of Wisconsin-Madison, May 1979
B.S.	Department of Electronics Engineering, Seoul National University, February 1975

PROFESSIONAL EXPERIENCE

3/1/99 - :	Professor and Chair Department of Bioengineering Professor of Electrical Engineering Adjunct Professor of Computer Science and Engineering, and Radiology University of Washington
4/1/04 - :	The W. Hunter and Dorothy L. Simpson Endowed Chair in Bioengineering University of Washington
9/16/90 - 2/28/99:	Professor of Electrical Engineering Adjunct Professor of Bioengineering, Computer Science and Engineering, and Radiology University of Washington
9/16/86 – 9/15/90:	Associate Professor of Electrical Engineering

	Adjunct Associate Professor of Bioengineering Adjunct Associate Professor of Computer Science (1988-) University of Washington
9/16/82 – 9/15/86:	Assistant Professor of Electrical Engineering Adjunct Assistant Professor of Bioengineering (1984-) University of Washington
1976 - 1982:	Research, Project and Teaching Assistant University of Wisconsin-Madison
1993-1994:	Sabbatical Leave Siemens Medical Systems, Ultrasound Group, Issaquah, WA

HONORS

Merit Scholarship (Korea), 1971-1974
University of Wisconsin Tuition Scholarship, September 1978
Finalist in ACEMB Student Paper Competition, Houston, September 1981
Finalist in SCAMC Student Paper Competition, Washington, November 1981
Physio Control Career Development Award, 1982-1985
Who's Who in Frontiers of Science and Technology, 1985
Whitaker Foundation Biomedical Engineering Grant Award, 1986
Nominated for UW TYEE Instructor of the Year, 1987
Who's Who in the World, 1987-88, 1990-91, 1993-94, 1994-95, 1995-96, 1996-97, ...
IEEE/EMBS Early Career Achievement Award, 1988
Outstanding Young Korean selected by the *Chosun-Ilbo*, 1990
One of the 39 "39ers" selected by the *Seattle Weekly*, 1990
IEEE/EMBS Distinguished Lecturer, 1991-
Who's Who in the West, 1993, 1994, 1995, 1997, 1998, ...
Who's Who in Science and Engineering, 1992, 1994, 1996, 1997, 1998, ...
Who's Who in Finance and Industry, 1996
Sony's Sabbatical Chair (did not take), 1993
Fellow of the American Institute of Medical and Biological Engineering, 1995
Fellow of the Institute of Electrical and Electronics Engineers (IEEE), 1996
Ho-Am Prize in Engineering, 2003
The W. Hunter and Dorothy L. Simpson Endowed Chair, 2004
Member of Tau Beta Pi and Eta Kappa Nu

TEACHING

Have received consistently very good to excellent ratings from students.

Undergraduate Courses Taught

Autumn 1982	EE371 Computer Operation and Organization (52 students)
Winter 1983	EE371 Computer Operation and Organization (50)
Spring 1983	EE479 Microcomputer System Design (21)
Autumn 1983	EE372 Introduction to Microprocessors (50)
Spring 1984	EE478 Design of Computer Subsystems (24)
Autumn 1984	EE478 Design of Computer Subsystems (32)
Winter 1985	EE478 Design of Computer Subsystems (31)
Autumn 1985	EE478 Design of Computer Subsystems (28)

Winter 1986	ENGR190 Introduction to Logical System Design (82)
Spring 1986	EE478 Design of Computer Subsystems (28)
Autumn 1986	EE478 Design of Computer Subsystems (26)
Winter 1987	EE478 Design of Computer Subsystems (19)
Autumn 1987	EE478 Design of Computer Subsystems (17)
Winter 1988	EE478 Design of Computer Subsystems (20)
Autumn 1988	EE478 Design of Computer Subsystems (20)
Winter 1989	EE370 Intr. to Digital Systems & Computers (26)
Winter 1989	EE478 Design of Computer Subsystems (22)
Spring 1989	EE370 Intr. to Digital Systems & Computers (63)
Autumn 1989	EE370 Intr. to Digital Systems & Computers (70)
Autumn 1989	EE478 Design of Computer Subsystems (16)
Autumn 1990	EE370 Intr. to Digital Systems & Computers (103)
Autumn 1990	EE478 Design of Computer Subsystems (21)
Winter 1991	EE370 Intr. to Digital Systems & Computers (41)
Autumn 1991	EE478 Design of Computer Subsystems (19)
Spring 1993	EE371 Digital Circuits and Systems (49)
Autumn 1994	EE371 Digital Circuits and Systems (47)
Spring 1995	EE478 Design of Computer Subsystems (25)
Autumn 1995	EE371 Digital Circuits and Systems (38)
Spring 1997	EE371 Digital Circuits and Systems (51)
Spring 1998	EE400B Systems Engineering and Medical Imaging Informatics (11)
Spring 2000	EE400K/BIOEN599L Systems Engineering and Healthcare Information Technologies (E-Medicine) (7)
Winter 2001	EE400B/BIOEN599D Systems Engineering and Electronic Medicine (10)
Spring 2002	BIOEN480A Bioengineering Research/Senior Capstone Design (5)

Graduate Courses Taught

Winter 1983	EE590 Parallel Computer Systems (30)
Autumn 1983	EE590 Advanced Microprocessors and Their Applications (35)
Winter 1984	EE590 Parallel Computer Systems (22)
Summer 1984	EE590 Image Processing Computer Systems (22)
Autumn 1984	EE590 Advanced Microprocessors and Their Applications (24)
Autumn 1984	EE599 Seminars on Digital Image Processing & Applications (30)
Winter 1985	EE599 Weekly Seminars on Image Processing (20)
Summer 1985	EE599 Image Processing Computer Systems (10)
Autumn 1985	EE590 Advanced Microprocessors and Their Applications (14)
Autumn 1985	EE599 Weekly Seminars on Image Processing (15)
Winter 1986	EE599 Design & Development of an Optimum Pipelined Image Processor (12)
Summer 1986	EE590 Image Processing Computer Systems (19)
Autumn 1986	EE590 Weekly Seminars on Image Processing (42)
Winter 1987	EE599 Weekly Seminars on Image Processing (33)
Spring 1987	EE590 16 and 32-bit Microcomputer System Design (5)
Spring 1987	EE590 Computer Image Generation (42)
Summer 1987	EE590 Image Processing Computer Systems (25)
Autumn 1987	EE500 Weekly Seminars on Image Processing (49)
Autumn 1987	EE599 DIN/PACS Seminars (9)
Winter 1988	EE500 Weekly Seminars on Image Processing (36)
Winter 1988	EE599 DIN/PACS Seminars (10)
Spring 1988	EE568 Image Processing Computer Systems (21)
Spring 1988	EE599 DIN/PACS Seminars (9)
Summer 1988	EE590 Computer Image Generation (32)

Autumn 1988	EE500 Weekly Seminars on Image Processing (38)
Winter 1989	EE500 Weekly Seminars on Image Processing (42)
Summer 1989	EE590 Computer Image Generation (40)
Autumn 1989	EE500 Weekly Seminars on Image Computing (50)
Winter 1990	EE500 Weekly Seminars on Image Computing (48)
Spring 1990	EE568 Image Processing Computer Systems (22)
Summer 1990	EE590 Computer Image Generation (25)
Autumn 1990	EE500 Weekly Seminars on Image Computing (72)
Winter 1991	EE568 Image Processing Computer Systems (23)
Winter 1991	EE500 Weekly Seminars on Image Computing (56)
Autumn 1991	EE500 Weekly Seminars on Image Computing (67)
Winter 1992	EE568 Image Processing Computer Systems (23)
Winter 1992	EE500 Weekly Seminars on Image Computing (46)
Spring 1992	EE590 Multimedia Chips and Systems (17)
Spring 1992	EE500 Weekly Seminars on Image Computing (41)
Autumn 1992	EE500 Weekly Seminars on Image Computing (51)
Winter 1993	EE568 Image Processing Computer Systems (17)
Winter 1993	EE500 Weekly Seminars on Image Computing (28)
Spring 1993	EE500 Weekly Seminars on Image Computing (36)
Autumn 1993	EE500 Weekly Seminars on Image Computing (40)
Winter 1994	EE500 Weekly Seminars on Image Computing (27)
Spring 1994	EE500 Weekly Seminars on Image Computing (20)
Autumn 1994	EE500 Weekly Seminars on Image Computing (57)
Winter 1995	EE568 Image Processing Computer Systems (18)
Winter 1995	EE500 Weekly Seminars on Image Computing (32)
Spring 1995	EE500 Weekly Seminars on Image Computing (39)
Spring 1995	EE599 Multimedia Video Processor (9)
Autumn 1995	EE500 Weekly Seminars on Image Computing (35)
Winter 1996	EE568 Image Processing Computer Systems (19)
Winter 1996	EE500 Weekly Seminars on Image Computing (34)
Spring 1996	EE590 Multimedia Processor Architecture & Their Programming (5)
Spring 1996	EE500 Weekly Seminars on Image Computing (14)
Autumn 1996	EE590 Multimedia Processor Architecture & Their Programming (8)
Autumn 1996	EE500 Weekly Seminars on Image Computing (30)
Winter 1997	EE568 Image Processing Computer Systems (13)
Winter 1997	EE500 Weekly Seminars on Image Computing (27)
Spring 1997	EE500 Weekly Seminars on Image Computing (27)
Autumn 1997	EE590 Multimedia Processor Architecture & Their Programming (8)
Autumn 1997	EE500 Weekly Seminars on Image Computing (53)
Winter 1998	EE500 Weekly Seminars on Image Computing (30)
Winter 1998	EE568 Image Processing Computer Systems (15)
Winter 1998	EE599 MPEG-4 Algorithms and Applications (7)
Spring 1998	EE500 Weekly Seminars on Image Computing (23)
Autumn 1998	EE590 Multimedia Processor Architecture & Their Programming (12)
Autumn 1998	EE500 Weekly Seminars on Image Computing (51)
Winter 1999	EE568 Image Processing Computer Systems (18)
Winter 1999	EE500 Weekly Seminars on Image Computing (32)
Spring 1999	EE500 Weekly Seminars on Image Computing (39)
Autumn 1999	EE500/BIOEN599K Weekly Seminars on Image Computing (31)
Autumn 1999	EE590/BIOEN599X Multimedia Processor Architecture & Their Programming (12)
Winter 2000	EE568/BIOEN568 Image Processing Computer Systems (13)
Winter 2000	BIOEN599J Weekly Seminars on Bioengineering (28)
Spring 2000	BIOEN599J Weekly Seminars on Bioengineering (25)
Autumn 2000	EE500B/BIOEN599K Weekly Seminar on Image Computing and

	Medical Imaging (36)
Autumn 2000	EE590N/BIOEN599X Mediaprocessors: Their Architectures and Programming (11)
Winter 2001	BIOEN599J Weekly Seminar on Bioengineering (18)
Spring 2001	BIOEN/EE568 Image Processing Computer Systems (8)
Spring 2001	BIOEN599J Weekly Seminar on Bioengineering (25)
Autumn 2001	BIOEN599K/EE500B Weekly Seminar on Image Computing and Medical Imaging (37)
Autumn 2001	BIOEN599X/EE590 Advanced Mediaprocessors and Their Architectures (9)
Winter 2002	BIOEN599J Weekly Seminar on Bioengineering (30)
Spring 2002	BIOEN/EE568 Image Processing Computer Systems (16)
Spring 2002	BIOEN599J Weekly Seminar on Bioengineering (19)
Autumn 2002	BIOEN599K/EE500B Weekly Seminar on Image Computing and Medical Imaging (54)
Winter 2003	BIOEN599J Weekly Seminar on Bioengineering (66)
Spring 2003	BIOEN599J Weekly Seminar on Bioengineering (44)
Spring 2003	BIOEN599H Technology Innovation and Commercialization (24)
Spring 2003	BIOEN/EE568 Image Processing Computer Systems (7)
Autumn 2003	BIOEN599E Introduction to Technology Commercialization (28)
Autumn 2003	BIOEN599K/EE500B Weekly Seminar on Image Computing and Medical Imaging (38)
Winter 2004	BIOEN599Y Studies in Technology Commercialization (13)
Winter 2004	BIOEN599J Weekly Seminar on Bioengineering (40)
Spring 2004	BIOEN/EE568 Image Processing Computer Systems (8)
Spring 2004	BIOEN599J Weekly Seminar on Bioengineering (30)
Autumn 2004	BIOEN599E Introduction to Technology Commercialization (47)
Winter 2005	BIOEN599Y Studies in Technology Commercialization (14)

New Courses Developed

Winter 1983	EE564 Parallel Computer Systems regular spring quarter graduate course
Autumn 1983	EE590 Advanced Microprocessors and Their Applications graduate course
Spring 1984	EE478 Design of Computer Subsystems regular senior elective course
Summer 1984	EE568 Image Processing Computer Systems regular spring quarter graduate course joint with Bioengineering
Autumn 1984	EE599 Seminars on Digital Image Processing & Applications regular quarterly seminar course EE500
Winter 1986	EE599 Design & Development of an Optimum Pipelined Image Processor experimental graduate course and constructed an image processor
Spring 1987	EE590 Computer Image Generation graduate course on computer graphics with Rich Johnston at BBN Delta Graphics

Autumn 1987	EE599 Seminars on Digital Imaging Network & Picture Archiving & Communications System regular Bioengineering course by Alan H. Rowberg in Spring, 1989
Spring 1992	EE590 Multimedia Chips and Systems graduate course on multimedia algorithms and systems based on research results and experience from UWGSP projects
Spring 1995	EE599 Multimedia Video Processor graduate course on the TMS320C80 Multimedia Video Processor based on our research on TMS320C80 chip architecture and its programming
Spring 1996	EE590 Multimedia Processor Architectures and Their Programming graduate course on the TMS320C80 Multimedia Video Processor and the next-generation programmable multimedia processors
Winter 1998	EE599 MPEG-4 Algorithms and Applications graduate course on studying the MPEG-4 Standard in detail and discussing its potential applications in medicine, distance learning, and others.
Spring 1998	EE400B Systems Engineering and Medical Imaging Informatics undergraduate course on systems engineering, medical informatics, and medical imaging systems based on the $514K grant from Hewlett-Packard Company
Winter 2000	BIOEN599J Weekly Seminars on Bioengineering graduate course
Spring 2002	BIOEN480A Bioengineering Research/Senior Capstone Design undergraduate core course
Spring 2003	BIOEN599H Technical Innovation and Commercialization Senior/graduate-level course for students in science and engineering
Autumn 2003	BIOEN599E Introduction to Technology Commercialization Senior/graduate-level course
Winter 2004	BIOEN599Y Studies in Technology Commercialization Senior/graduate-level course

Curriculum Improvements

EE371, Improved the course contents significantly by emphasizing the microprogramming technique and operating system concepts. Also developed and implemented a cross compiler software package for microprogramming simulation. Autumn 1982.

EE372, Changed the course from assembly language programming to microprocessor software and hardware, Autumn 1983.

ENGR190, Restructured and significantly upgraded the course contents with a new textbook to change it into EE370, Winter 1986.

EE370, EE478, Added a laboratory to introduce students to the VALID CAE (Computer Aided Engineering) schematic capture and simulation software on the VAX Workstations, Winter 1989.

EE478, Introduced advanced hardware design issues, e.g., Verilog hardware description language, and noise sources in high-speed digital system design, and how to control them, 1990.

Led the committee in revising the undergraduate courses in Electronics and Computer Hardware, ENGR275, EE371 (a new core course under the approved curriculum), EE372, EE471, EE476, EE478, and EE479), 1991.

Selected the textbook, and developed the course outline and all the laboratories, and taught EE371, a new 5-credit core course on digital circuits and systems which was implemented in Winter/Spring 1993.

RESEARCH

Current Active Research Grants and Contracts

Principal Investigator, "Mapping of Ultrasound Algorithms onto a Mediaprocessor-based Architecture," Hitachi Medical Corporation, 2/01/00 -1/31/05, $1,863.320.

Principal Investigator, "Research and Development on the University of Washington Image Computing Library for MAP," Hitachi, Ltd., 3/1/98 - 2/28/05, $750,000.

Principal Investigator, "MAP University of Washington Image Computing Library Consortium," Various Companies, 5/19/99 – 12/31/04, $320,000.

Principal Investigator, "Prostate Boundary Detection in Ultrasound Images," National Institutes of Health, 9/01/00 - 8/31/05, $203,619.

Principal Investigator, "University of Washington Mediaprocessor User Consortium," Various Companies, 3/1/01 – 2/28/05, $148,000.

Principal Investigator, "Bioengineering in the 21st Century," Whitaker Foundation, 5/1/01 – 4/30/06, $10,000,000.

Principal Investigator, "C64 University of Washington Image Computing Library Consortium," Various Companies, 3/1/02 - 2/29/05, $96,000.

Principal Investigator, "Singapore-University of Washington Alliance in Bioengineering," National Science and Technology Board in Singapore, 7/1/02 – 5/31/07, $14,000,000.

Investigator, "Intraoperative Dose Optimization for Prostate Brachytherapy," U.S. Army, 5/1/2003 – 4/30/2006, $568,500.

Previous Research Grants and Contracts

Principal Investigator, "Three-dimensional Reconstruction, Computing and Image Processing for the Flow Optical Tomography System," VisionGate, 11/16/02 - 5/15/03, $3,022.

Principal Investigator, "Digital Radiography Computing with Mediaprocessors," Canon Inc.,

1/1/01 – 12/31/01, $300,000.

Principal Investigator, "Image and Video Computing with the Programmable Mediaprocessors," Canon Inc., 12/16/97 – 2/19/02, $1,500,000.

Principal Investigator, "MPEG-4 Decoder Development on the V4400 and Architectural Evaluation for Future Mediaprocessors," Micron Technology, Inc., 5/8/00 – 12/31/01, $200,927.

Consultant, "Alzheimer Disease Research Center," George M. Martin, Center Director, PI, Consultant to the General Autopsy and Neuropathology Service Core assisting in the implementation of a program of quantitative digital image analysis systems, National Institutes of Health, $116,933 per year, Funding period: 5/1/95 - 4/30/00.

Principal Investigator "Development of Core Image Computing Functions on the ManArray Architecture," Billions of Operations Per Second (BOPS), 11/1/99 - 4/30/00, $41,131.

Principal Investigator, "Development of a Multimedia Computing Engine Architecture, Library and Applications for the HMPV Processor," Hitachi, Ltd., 12/18/95 - 2/29/98, $750,000.

Consultant, "Integrated Medical Imaging Software Using Distributed Objects," Vikram Chalana (StatSci, Inc.), PI, National Institutes of Health, 1/1/98 - 12/31/99, $750,000.

Principal Investigator, "Development of Image Computing Technologies and their Applications in Ultrasound Imaging," Siemens Medical Systems, 8/16/92 - 8/15/00, $957,887.

Principal Investigator, "A New Curriculum on Systems Engineering, Medical Imaging Informatics and Imaging Systems," Hewlett-Packard Company, 6/16/97 - 6/15/99, $514,000 + $150,000 UW matching.

Principal Investigator, "UWGSP10: Generalized Backend Computing Board for Medical Ultrasound Processing," Washington Technology Center and Siemens Medical Systems, 8/16/97 - 8/15/99, $819,656.

Principal Investigator, "Contrast Enhancement of Video Signals for Industrial Process Monitoring, Washington Technology Center and Quadtek, Inc., 3/16/97 - 6/15/98, $26,500.

Principal Investigator, "Image Computing Library Consortium," 1/1/95 - 12/31/97, various companies, $500,000.

Principal Investigator, "An Optimized Telemedicine Workstation," Washington Technology Center and Precision Digital Images, 7/1/95 - 6/30/97, $200,000.

Co-Principal Investigator, "Communicating Situation Awareness in Virtual Environments," U.S. Air Force, 1/1/93 - 12/31/96, $2,500,000.

Principal Investigator, "Predicting Transvenous Defibrillation Efficacy," National Institutes of Health, 8/1/92 - 7/31/96, $708,444.

Principal Investigator, "MPEG-2 Decoding/Encoding," Hitachi, Ltd., 3/16/95 - 9/15/95, $30,000.

Principal Investigator, "UWGSP7: An Optical Imaging System to Aid Neurosurgeons," Washington Technology Center and Optimedx, 7/1/93 - 6/30/95, $280,000.

Investigator, "Advanced Human Interfaces for Telemedicine," Advanced Research Projects Agency, 7/15/94 - 7/15/95, $340,000.

Principal Investigator, "Computer-Aided Inspection of Potatoes and Other Agricultural Products by Digital Image Processing," Washington Technology Center, 03/01/95 - 06/30/95, $25,000.

Principal Investigator, "Design and Implementation of a ROC Study on MDIS Compression," U.S. Army; Loral; Siemens Gammasonics, Inc., 06/01/93 - 06/15/95, $78,331.

Principal Investigator, "UWGSP5: A Highly Integrated Low-Cost Multimedia System," GoldStar Co. Ltd., 7/1/91 - 8/31/94, $650,000.

Principal Investigator, "Implementation of Assistive Devices to Aid the Handicapped as Student Design Projects," National Science Foundation, 3/1/88 - 11/30/93, $76,168.

Principal Investigator, "Quality Control Assessment for the Medical Diagnostic Imaging Support (MDIS) System," U.S. Army, 12/15/92 - 11/14/93, $24,999.

Principal Investigator, "Parallel Image Computing Workstations for Multimedia," Washington Technology Centers, 7/1/91 - 6/30/93, $50,000.

Principal Investigator, "High-Quality Three-Dimensional Image Compression Techniques," Washington Technology Centers, 7/1/90 - 6/30/93, $58,750.

Principal Investigator, "Teleimaging Algorithm Development," Texas Instruments, 4/1/90 - 3/31/93, $125,000.

Co-Principal Investigator, "IBM-UW Joint Study in Advanced Medical Imaging Within the Center of Excellence on Imaging Systems Optimization," (Dr. Greg Zick, Co-Principal Investigator), IBM, 4/1/90 - 3/31/93, $3,000,000.

Principal Investigator of the Image Analysis Core to the Program Project, "Mechanisms of Acute Vascular Reaction to Injury," (Dr. S. M. Schwartz, Program Director), National Institutes of Health, 3/1/88 - 2/28/93, core's total amount $193,584.

Principal Investigator, "University of Washington Graphics Accelerator (UWGPX)," VLSI Technology, 7/1/91 - 12/31/92, $510,000.

Principal Investigator, "Development and Validation of Anatomy-Based Three- Dimensional Thorax Models with FEM," Medtronic, Inc., 5/1/91 - 12/31/92, $35,000.

Principal Investigator, "One GFLOPS Workstation for Real-Time Imaging and 3-D Graphics," Samsung Advanced Institute of Technology, 9/1/89 - 3/31/92, $635,515.

Principal Investigator, "Development of an Anatomy-Based High-Resolution Three-Dimensional Human Thorax Model," Physio Control Corporation, 1/16/90 - 12/31/91, $63,000.

Principal Investigator, "Design of a Special-Purpose Processor for Imaging, Graphics and Multimedia Support in the Intelligent Computer," Electronics and Telecommunications Research Institute, 4/1/91 - 9/30/91, $50,000.

Principal Investigator, "Development of an Interactive Floating-Point 2-D Image Filtering Library with a Graphical User Interface," Naval Research Laboratory, 7/16/89 - 6/30/91, $62,076.

Principal Investigator, "Distributed Scheduling Algorithms for Sharing Workstations and Supercomputers in a Networked Biomedical Image Computing Environment," The Keck Foundation, 8/16/89 - 6/15/91, $25,000.

Principal Investigator, "High-Speed Data Interchange Scheme for the Next Generation Multiprocessor System," Electronics and Telecommunications Research Institute, 10/1/89 - 3/31/91, $90,987.

Co-Principal Investigator, "CT Reconstruction," (Dr. Alan H. Rowberg, Principal Investigator), Institute for Radiological Image Sciences, 10/1/88 - 12/31/90, $50,200.

Principal Investigator, "High-Performance Imaging and Graphics Workstation," Daewoo Telecom Company, 9/1/89 - 10/31/90, $210,919.

Principal Investigator, "High-Performance Multiprocessor Bus Design," Electronics and Telecommunications Research Institute, 11/24/88 - 9/15/90, $99,000.

Investigator, "AUV Lens," (Dr. Ed Belcher, Principal Investigator), Naval Research Laboratory, 1/1/89 - 6/30/90, $180,000.

Consultant, "Alzheimer Disease Research Center," George M. Martin, Center Director, consultant to the General Autopsy and Neuropathology Service Core assisting in the implementation of a program of quantitative digital image analysis systems, National Institutes of Health, 10/1/85 - 6/30/90, $4,100,000.

Investigator (in charge of engineering studies), "Digital Imaging Network & Picture Archiving and Communications System (DIN/PACS)," (Dr. John W. Loop, Principal Investigator), U.S. Army, 9/22/86 - 12/31/89, $2,750,000.

Principal Investigator, "User Interface and Acceptance Studies with DIN/PACS Workstation," Texas Instruments, 1/1/89 - 12/31/89, $15,000 plus $75,000 equipment.

Principal Investigator, "Pattern Recognition and Image Processing for Automatic Feature Detection from Maps and Aerial Photographs," BBN Delta Graphics, 1/1/88 - 6/30/89, $25,000.

Co-Principal Investigator, "Machine Vision for Automated Manufacturing," National Science Foundation Equipment Grant, 6/10/87 - 2/28/89, $100,000.

Principal Investigator, "Development of Image Processing Applications Hardware and Software for the TI's SN74ACT8837," Texas Instruments, 11/1/87 - 11/30/88, $67,500.

Principal Investigator, "Development of a General-Purpose Three-Dimensional Human Body Computer Model," Physio Control Corporation and Cardiac Pacemakers Inc., 3/1/84 - 6/15/88, $73,396.

Investigator, "Mechanisms of Acute Vascular Reaction to Injury," Program Project (Dr. Schwartz, Program Director), 10% effort in a project developing a powerful microcomputer-based image processing computer system, National Institutes of Health, 3/1/85 - 2/29/88, $3,848,086.

Co-Principal Investigator, "3-D Analysis of MRI of the Spine," Siemens Medical Systems, 9/1/87 - 2/29/88, $8,200.

Principal Investigator, "Intelligent Workstation Multifunction Processor," Boeing High Tech Center, 4/1/87 - 12/31/87, $49,999.

Principal Investigator, "Integration of the Optical Disk to the Interactive Graphics System," Northwest Research Associates, 4/1/87 - 7/31/87, $7,703.

Principal Investigator, "Biomedical Image Processing Systems for Quantitative Microscopy," The Whitaker Foundation, 3/1/86 - 6/15/87, $47,522.

Principal Investigator, "Display Generation Requirements Study," Boeing Military Airplane Company, 10/10/86 - 3/31/87, $23,594.

Principal Investigator, "Electrical Impedance Technique in Medical Body Imaging," National Institutes of Health, 3/1/84 - 2/28/87, $204,747.

Principal Investigator, "Development of graphics and image processing application software and supporting hardware for the TMS34010 Graphics System Processor (GSP)," Texas Instruments Inc., 2/1/86 - 12/31/86, $50,000.

Principal Investigator, "Development of virtual image processing software package in Intel System 310", and "Finite element model implementation in Intel System 310," Intel Corporation, 12/15/84 - 9/30/86, $70,000.

Principal Investigator, "An optimized Fourier transform processor," Boeing Aerospace Company, 12/15/85 - 7/31/86, $24,999.

Principal Investigator, "Development of a Microprogrammable Computer System based on NCR/32 32-bit Microprocessor Chip Sets," NCR Corporation, 4/1/85 - 3/31/86, $10,400.

Principal Investigator, "Development of the Layered Software for the Digital Image Processing Computer Systems," University of Washington Graduate School, 1/15/85 - 10/15/85, $8,339.

Principal Investigator, "Implementation of the Three-Dimensional Human Body Model," University of Washington Graduate School, 7/1/83 - 6/30/84, $4,300.

Individual Research Program

Mediaprocessor architectures and multimedia systems.

Distributed diagnosis and home healthcare.

Ultrasound imaging.

Multimodality image analysis and processing.

Applications in medical imaging, telemedicine and medical informatics.

Pipelined and parallel processing computer architecture for imaging and 3-D graphics.

Image & video compression.

Digital imaging network and picture archiving & communications system (DIN/PACS).

Computer modeling based on finite element method & experimental techniques to calculate electric and magnetic field distributions.

Electronic assistive devices for the handicapped.

Pattern recognition & expert system applications in image understanding.

Undergraduate Students Supervised by Y. Kim

Every BSEE & BSCompE student has done an individual project and written a report.

1. Gary Shankman (BSEE, 1983),
2. Mark Westlund (BSEE, 1983)
3. John Gregor (BSEE, 1984),
4. Eric Molver (BSEE, 1984),
5. Mike Upton (BSEE, 1984),
6. Shawn McCutcheon (BSEE, 1985)
7. Jeff McCabe (BSEE, 1985),
8. Gale Paeper (BSEE, 1985)
9. John Ardussi (BSEE, 1985),
10. Ted Kummert (BSEE, 1985)
11. Jeff Reeve (BSEE, 1985),
12. Gerald Simmons (BSEE, 1985)
13. Lien Le (BSEE, 1985),
14. Michael Kahn (BSEE, 1985)
15. Ken Umino (BSEE, 1986),
16. Long Nyuyen (BSEE, 1986)
17. Jocelyn Lum (BSEE, 1986),
18. Sang-Ug Kim (BSEE, 1986)
19. Jean McAuliffe (BSEE, 1986),
20. Doran Akutagawa (BSEE, 1986)
21. Stella Chow (BSEE, 1986),
22. Van Ly (BSEE, 1986)
23. Patty Chinn (BSEE, 1987),
24. Albert Chung (BSEE, 1987)
25. Don Dovey (BSEE, 1987),
26. Jack Poon (BSEE, 1987)
27. Erik Godo (BSEE, 1987),
28. Christine Griffen (BSEE, 1987)
29. Brad Lovering (BSEE, 1987),
30. Karl Mills (BSEE, 1987)
31. David Rubens (BSEE, 1987),
32. Joe Stegman (BSEE, 1987)
33. Bert Sullam (BSEE, 1987),
34. Karl Kleiner (BSEE, 1988)
35. Richard Burton (BSEE, 1988),
36. Allan Weidenheimer (BSEE, 1988)
37. Alison Lytle (BSEE, 1988),
38. Chris Guzak (BSEE, 1988)
39. David Wu (BSEE, 1989),
40. Andrew Nichols (BSEE, 1989)
41. Hsi-Jung Wu (BSCompE, 1989),
42. Daniel Morris (BSEE, 1989)
43. Jeff Schroeder (BSCompE, 1989),
44. Will Cummings (BSEE, 1989)
45. Steve Martin (BSEE, 1989),
46. Steve Bohrer (BSEE, 1989)
47. M. Mojirsheiban (BSEE, 1989),
48. Kurt Sahlin (BSEE, 1989)
49. John Ogden (BSEE, 1989),
50. Larry Wiedenhoft (BSEE, 1990)
51. Greg Stock (BSEE, 1990).
52. Khai Trinh (BSEE, 1990)
53. Kraig Brockschmidt (BSCompE, 1990),
54. John Yeh (BSEE, 1990)
55. Anthony Hawkins (BSEE, 1990),
56. Anthony Wong (BSEE, 1990)
57. Radwan Faraj (BSEE, 1990),
58. Alex Umino (BSEE, 1991)
59. Jon Chinn (BSEE, 1991),
60. Wilfred Wong (BSEE, 1991)
61. Adam Lew (BSEE, 1991),
62. Doug Nakano (BSEE, 1992)
63. Vicki Yee (BSEE, 1992),
64. Brian Read (BSEE, 1993)
65. Chris Dobbs (BSEE, 1995),
66. Edwards Kaetz (BSEE, 1995)
67. Myeong Lee (BSEE, 1996)
68. Peter Mattson (BSEE, 1997)
69. Grant Kobayashi (BSEE, 1999)
70. Janice Kim (BSE, 2001)
71. Dominic Wu (BSEE, 2003)
72. Travis Wilkins (BSEE, 2003)
73. Jai Modai (BSCompE, 2004)

Mary Gates Scholars

1. Peter Mattson
2. Grant Kobayashi
3. Janice Kim

Barry M. Goldwater Scholar

1. Janice Kim

MS Degrees Supervised by Y. Kim

Every student (MSEE and MSBIOEN) has written his/her Master's thesis.

1. Ruey-Fong Yen (MSEE, 4/84)
2. Hok-Wai Woo (MSEE, 5/84)
3. Mahboob Ahmed (MSEE, 8/84)
4. Brian Hargus (MSEE, 9/84)
5. Ron Timm (MSEE, 11/84)
6. Bill Nicholls (MSEE, 12/84)
7. Anthony Luk (MSEE, 3/85)
8. Brian Buchanan (MSEE, 5/85)
9. Steve Elliott (MSEE, 6/85)
10. Tyler Brooks (MSEE, 6/85)
11. Song Choi (MSEE, 11/85)
12. Paul Mathews (MSEE, 12/85)
13. Paul Yeung (MSEE, 3/86)
14. Scott Schubert (MSEE, 3/86)
15. Ben Fahy (MSEE, 5/86)
16. Hwan Choi (MSEE, 5/86)
17. Tom Alexander (MSEE, 5/86)
18. Brad Tupper (MSEE, 5/86)
19. Dean Verheiden (MSEE, 9/86)
20. Bob Kaucic (MSEE, 1/87)
21. Bob Miyaoka (MSEE, 2/87)
22. Joe Chauvin (MSEE, 2/87)
23. Alan Steiner (MSEE, 2/87)
24. Paul Schimpf (MSEE, 2/87)
25. James Moore (MSEE, 5/87)
26. Paul Budak (MSEE, 5/87)
27. John Blattenbauer (MSEE, 5/87)
28. Peter Jurgens (MSEE, 5/87)
29. Greg Bauer (MSEE, 6/87)
30. David Barnett (MSEE, 10/87)
31. James Turner (MSEE, 2/88)
32. Zhipu Zhu (MSEE, 3/88)
33. Rick Pier (MSEE, 5/88)
34. Heinz-Gunter Zieber (MSEE, 6/88)
35. Grace Bartoo (MSEE, 12/88)
36. Jim Gee (MSEE, 1/89)
37. Patty Chinn (MSEE, 1/89)
38. Woobin Lee (MSEE, 11/89)
39. Paul Wilhelm (MSBIOEN, 12/89)
40. Andy Luedtke (MSEE, 1/90)
41. Karl Mills (MSEE, 3/90)
42. Dawn Blilie (MSBIOEN, 3/90)
43. Gilman Wong (MSEE, 5/90)
44. Clark Haass (MSEE, 6/90)
45. Chi-Shung Wang (MSEE, 6/90)
46. Ramesh Panwar (MSEE, 6/90)
47. Tom Andersen (MSEE, 1/91)
48. Marielena Algorri (MSBIOEN, 6/91)
49. Warren Edwards (MSEE, 8/91)
50. David Yee (MSEE, 8/91)
51. Peng Zhang (MSEE, 2/92)
52. Stuart Milton (MSEE, 5/92)
53. Bingzhong Guan (MSEE, 5/92)
54. Alex Han (MSEE, 5/92)
55. Ed Chen (MSEE, 8/92)
56. Sumeet Agrawal (MSEE, 8/92)
57. Mike Nakahara (MSEE, 3/93)
58. Yuhong Xiong (MSEE, 3/93)
59. Larry Wolfe (MSEE, 3/93)
60. Vikram Chalana (MSBIOEN, 6/93)
61. James Cabral (MSEE, 12/93)
62. David Parsons (MSEE, 12/93)
63. Andrew Alleman (MSEE, 3/94)
64. Jeffrey Reeve (MSEE, 3/94)
65. Nandini Shrinidhi (MSEE, 3/94)
66. Thomas Holcomb (MSEE, 4/94)
67. Joe Young (MSEE, 7/94)
68. Xinyu Wang (MSBIOEN, 7/94)
69. Philip Sinn (MSEE, 12/94)
70. Steve Jantz (MSEE, 12/94)
71. Moots li (MSEE, 12/94)
72. John Bush (MSEE, 5/95)
73. Hao Wu (MSEE, 4/96)
74. Zhong Jin (MSEE, 5/96)
75. Cary Collins (MSEE, 5/96)
76. Sayan Pathak (MSBIOEN, 10/96)
77. Christian DeForge (MSEE, 10/96)
78. Owen Evans (MSEE, 12/96)
79. Liyong Zhou (MSEE, 12/96)
80. Peter Gorgone (MSEE, 7/97)
81. Ann Chamberlain (MSEE, 9/97)
82. Frederic Noraz (MSEE, 8/98)
83. Inga Stotland (MSEE, 12/98)
84. Niko Pagoulatos (MSBIOEN, 12/98)
85. Kevin Hilman (MSEE, 1/99)
86. John Angulo (MSEE, 3/99)
87. Hiroki Mizosoe (MSEE, 3/99)
88. Svetlana Zamberg (MSEE, 6/99)
89. Yoochang Jung (MSEE, 8/99)
90. Todd Schoepflin (MSEE, 8/99)
91. Lakshmanan Gopishankar (MSEE, 4/00)
92. Ken Haberman (MSBIOEN, 8/00)
93. Coskun Mermer (MSEE, 9/00)
94. Rohit Garg (MSEE, 3/01)
95. Michael Grow (MSEE, 6/01)
96. Siddhartha Sikdar (MSEE, 12/01)
97. Kerem Karadayi (MSEE, 3/02)
98. Vijay Shamdasani (MSBIOEN, 6/02)
99. Maikael Thomas (MSEE, 8/02)
100. Anup Agarwal (MSEE, 8/02)
101. Ismail Tutar (MSEE, 3/03)

Ph.D. Degrees Supervised by Y. Kim

1. David Arpin (Ph.D., 5/86), "A parallel processor for the solution of large, sparse symmetric linear systems," in Electrical Engineering, UW.

2. Hok-Wai Woo (Ph.D., 1/90), "Development of a new reconstruction algorithm and an electrical impedance tomography system," in Electrical Engineering, UW.

3. Hwan S. Choi (Ph.D., 7/90), "Partial volume tissue classification of multichannel MRI and its applications - A mixel model," in Electrical Engineering, UW.

4. J. Ben Fahy (Ph.D., 1/91), "A language support system for image processing," in Electrical Engineering, UW.

5. Dean Verheiden (Ph.D., 10/91), "Deterministic scheduling algorithms for distributed image processing," in Electrical Engineering, UW.

6. Larry DeSoto (Ph.D., 11/92), "A three-dimensional distortion model for magnetic resonance images used in image-guided surgery," in Electrical Engineering, UW.

7. Heesub Lee (Ph.D., 12/92), "A classified vector quantization using prediction and its subjective evaluation for X-ray CT images," in Electrical Engineering, UW.

8. Cam Ritchie (Ph.D., 9/93), "Methods for reducing motion artifacts in computed tomography scans of the chest," in Bioengineering, UW.

9. Dawn Blilie Jorgenson (Ph.D., 6/94), "Optimizing current delivery in defibrillation: finite element models and experimental validation," in Bioengineering, UW.

10. Grace Bartoo (Ph.D., 1/95), "Quantitative neuropathologic measures in genetic subgroups of Alzheimers disease," in Bioengineering, UW.

11. Paul Schimpf (Ph.D., 9/95) "Efficient modeling of bioelectric fields," in Electrical Engineering, UW.

12. Jihong Kim (Ph.D., 12/95), "Toward more efficient domain-specific image computing," in Computer Science & Engineering, UW.

13. Vikram Chalana (Ph.D., 6/96), "Deformable models for segmentation of medical ultrasound images," in Bioengineering, UW.

14. Woobin Lee (Ph.D., 4/97), "Architectures and algorithms for MPEG video coding," in Electrical Engineering, UW.

15. Donglok Kim (Ph.D., 9/97), "Extended data cache prefetching using a reference prediction table," in Electrical Engineering, UW.

16. Christopher Basoglu (Ph.D., 9/97), "A generalized programmable system and efficient algorithm for ultrasound backend processing," in Electrical Engineering, UW.

17. Warren Edwards (Ph.D., 6/99), "Three-dimensional ultrasound for clinical applications," in Electrical Engineering, UW.

18. Yanqun Wang (Ph.D., 6/99), "Analysis of defibrillation efficacy and investigation of impedance cardiography with finite element models incorporating anisotropic myocardium," in Bioengineering, UW.

19. George York (Ph.D., 8/99), "Architecture and algorithms for a fully programmable ultrasound

system," in Electrical Engineering, UW.

20. Sayan Pathak (Ph.D., 6/00), "Computer-aided segmentation of anatomical features in transrectal ultrasound prostate images," in Bioengineering, UW.
21. Shijun Sun (Ph.D., 7/00), "Video object segmentation and tracking using VSnakes," in Electrical Engineering, UW.
22. Ravi Managuli (Ph.D., 8/00), "Programmable ultrasound color flow system," in Electrical Engineering, UW.
23. Niko Pagoulatos (Ph.D., 3/02), "Algorithms and systems for registration of two and three-dimensional ultrasound images," in Electrical Engineering, UW.
24. Stefan Berg (Ph.D., 5/02), "A prefetching memory system for mediaprocessor," in Computer Science & Engineering, UW.
25. Chris Chung (Ph.D., 9/02), "Design and evaluation of a multimedia computing architecture based on a 3D graphics pipeline," in Electrical Engineering, UW.
26. Lixin Gong (Ph.D., 12/02), "Ultrasound prostate image segmentation and registration," in Electrical Engineering, UW.
27. Wenfeng Gao (Ph.D., 3/03), "Real-time video postprocessing algorithms and metrics," in Electrical Engineering, UW.
28. Christopher Lau (Ph.D., 8/03), "Systems and methods for patient-centered e-health services," in Bioengineering, UW.
29. Todd Schoepflin (Ph.D., 9/03), "Algorithms for estimating mean vehicle speed using uncalibrated traffic management cameras," in Electrical Engineering, UW.

Research Assistant Professor

Dr. Thomas Alexander, 6/90 - 6/92
Dr. Donglok Kim, 12/97 – 6/01
Dr. Ravi Managuli, 1/01 – 7/03

Visiting Associate Professor

Dr. HyunWook Park, 9/98 – 8/99

Post-Doctoral Research Associates

Dr. HyunWook Park, 7/89 - 3/92
Dr. Min-Hwan Kim, 1/91 - 12/91
Dr. Ja-Il Koo, 3/91 - 3/93
Dr. Chun Sung Kim, 8/92 - 2/93
Dr. Cam Ritchie, 10/93 - 11/94
Dr. Ravi Managuli, 8/00 - 12/00
Dr. Justine Liu, 10/01 - 6/02
Dr. Dong-Gyu Sim, 4/02 -

Research Engineer

Stuart Milton, 5/92 - 4/94

Visiting Scientists

Dr. Kil-Su Eo, 1/90 - 2/92
Dr. Hyung-Sik Choi, MD, 1/92 - 2/93
Yukio Chiba, 4/98 - 12/99
Aikira Tsukui, 4/00 - 9/00
Hitoshi Inoue, 3/01 - 6/01
Tetsuya Hayashi, 4/00 - 4/02
Dr. Atsutaka Okizaki, 6/03 – 6/04
Dr. Sosuke Miyoshi, 3/03 -

Visiting Scholars

Ikuo Tsukagoshi, 9/87 - 9/88
Jae-Jeong Jong, 8/91 - 8/92
Nam-Geol Lee, 8/91 - 12/92
Hak-June Kim, 7/92 - 3/94
Takashi Kameya, 8/03 – 9/04
Jin-Ryong Yoo, 8/03 – 7/04

Visiting Graduate Students

Christian DeForge from IRESTE (Nantes, France), 1/94 - 6/94
Frederic Noraz from IRESTE (Nantes, France), 1/96 - 6/96
Kristell Villalard from IRESTE (Nantes, France), 1/98 - 6/98

PUBLICATIONS

Journal Articles

1. Kim, Y. and Tompkins, W. J., "Forward and inverse high-frequency electrocardiography," *Med. Biol. Eng. Comput.*, Vol. 19, pp. 11-22, 1981.

2. Kim, Y., Webster, J. G. and Tompkins, W. J., "Electrical impedance imaging of the thorax," *J. Microwave Power*, Vol. 18, pp. 245-257, 1983.

3. Kim, Y., Webster, J. G. and Tompkins, W. J., "Simulated and experimental studies of temperature elevation around electrosurgical dispersive electrodes," *IEEE Trans. Biomed. Eng.*, Vol. 31, pp. 681-692, 1984.

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b. Abstracts

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SERVICE ACTIVITIES

Department

Member of the Graduate Study Committee, 1982-1984.
Member of the Graduate Admissions Subcommittee, 1982-1984.
Member of the Graduate Financial Aid Subcommittee, 1982-1984.
Member of the Computer Engineering Faculty Search Committee, 1983.
Member of the Undergraduate Admissions Appeals Committee, 1983-1986.
Chairman of the Undergraduate Admissions Appeals Committee, 1984.
Member of the Computer Engineering Faculty Search Committee, 1984-1985.
Member of the Undergraduate Admissions Committee, 1986, 1987.
Member of the Support Services & Facilities Committee, 1984-1987.
Set up the Advanced Microprocessor Laboratory (Intel 8086's, Motorola's 68000's, National 32016's, and their development facilities), 1984-1987.
Faculty Supervisor of the EE Stockroom, 1985-1990.
Member of the Ad Hoc Undergraduate Curriculum Review Comm., 1986-1987.
Member of the Electrical Engineering Faculty Search Committee, 1986-1987.

Member of the Computer Engineering Faculty Search Committee, 1987-1988.
Member of the Development Committee, 1987-1988.
Chairman of the Undergraduate Admissions Committee, Spring, 1988.
Chairman of the Undergraduate Admissions Appeals Committee, Fall, 1988.
Chairman of the Computer Engineering Faculty Search Committee, 1988.
Chairman of the Electrical Engineering Faculty Search Committee, 1988-1990.
Chairman of the Merit Review Committee for Assistant Professors, 1989.
Member of the EE/CSE Curriculum Coordination Committee, 1990.
Member of the EE Departmental Building Committee, 1989-1990.
Chairman of the EE Strategic Planning Committee, 1990-1991.
Member of the EE Department Advisory Committee, 1990-1991, 1995-1996.
Member of the Neopath Professorship Search Committee, 1995-1996.
Chair of the Neopath Professorship Search Committee, 1996-1998.
Chair of the EE Computers Group, 1995-1996.
Member of the Electrical Engineering Faculty Search Committee, 1996-1997.
Set up the Digital Electronics and Computer Design Laboratory in 1984.
Set up the Image Computing Systems Laboratory (ICSL) in 1984 and in charge of it.
Chair of the Bioengineering Faculty Search Committee, 1999-2002.
Chair of the Bioengineering Graduate Admissions Committee, 1999-2001.

College & University

Member of the Advisory Group for Pathology Image Analysis Laboratory, 1984- 1989.
Member of the Advisory Board for Engineering Continuing Education, 1987-1988.
Member of the Ad Hoc Committee on Supercomputing in Imaging, 1987-1990.
Member of the Program Committee for the Washington Exhibition of Science & (WEST-88), 1988.
Member of the Washington Technology Center Advisory Committee on Computer Systems and Software, and the WTC Long Range Research Planning Committee, 1988-1989.
Member of the EE Chairman Search Committee, 1988-1989.
Member of the proposal writing team for the NSF Engineering Research Center on Imaging Systems Optimization, 1989-1990.
Interim Director of the Center for Imaging Systems Optimization (CISO), 1991.
Member of the Engineering Courses Committee, 1989-1992.
Chairman of the College Courses Committee VIII (ENGR 275), 1989-1992.
Member of the UW Interdisciplinary Research Committee, 1991-1992.
Member of the Executive Committee for Center for Imaging Systems Optimization, 1990-1993.
Member of the UW Provost Search Committee, 1993.
Member of the Classified & Proprietary Research Committee, 1994-1995.
Member of the Executive Committee for the Diagnostic Imaging Sciences Ctr. (DISC), 1991-1996.
Member of the Advisory Committee on Medical Informatics, 1995.
Member of the UW Provost Search Committee, 1995-1996.
Chairman of the Bioengineering Chair Search Committee, 1996-1997.
Member of the Medical School Admissions Committee, 1999-2000.
Member of the School of Medicine Executive Committee, 1999-
Member of the College of Engineering Executive Committee, 1999-
Member of the UW Vice President for Minority Affairs Search Committee, 2000-2001.
Member of the UW Law School LL.M. Program Review Committee, 2001-2002.
Member of the Radiology Chair Search Committee, 2001-2002.
Member of the School of Medicine research Planning Committee, 2002-
Founder and Director of the C80 University of Washington Image Computing Library Consortium, 1994-1997.
Founder and Director of the MAP University of Washington Image Computing Library Consortium, 1999-
Founder and Director of the UW Mediaprocessor User Consortium, 2000-2002.

Founder and Director of the C64 University of Washington Image Computing Library Consortium, 2001-

Editorial Boards

Member, Editorial Board of the *Journal of Multimedia Tools and Applications*, 1994-1998.
Member, Editorial Board of the *Telemedicine Journal*, 1995-2001.
Member, Editorial Board of the *IEEE Press Series in Biomedical Engineering*, 1996-
Member, Advisory Board of the *IEEE Transactions on Biomedical Engineering*, 1996-
Member, Editorial Board of the *IEEE Transactions on Information Technology in Biomedicine*, 1996-
Member, Editorial Board of the *Annual Reviews of Biomedical Engineering*, 1997-2002.
Member, Editorial Board of the *Proceedings of the IEEE*, 2002-
Guest Editor, *Parallel Computing*, 1997-1998.
Guest Editor, *International Journal of Imaging Systems & Technology*, 1997-1998.

Professional Societies

Fellow of the IEEE and member of
- IEEE Computer Society
- IEEE EMB Society
- IEEE Education Society
- IEEE Signal Processing Society
- IEEE Circuits and Systems Society

Fellow of the American Institute of Medical and Biological Engineering (AIMBE)
Member of SPIE (International Society for Optical Engineering)
IEEE/ABET (Accreditation Board for Engineering and Technology) Program Evaluator of Bioengineering and Computer Engineering, 1992-
Chairman, IEEE *Transactions on Medical Imaging* Steering Committee, 1993-1994.
Chairman, IEEE *Transactions on Medical Imaging* Editor-in-Chief Search Committee, 1994.
Member of the Administrative Committee of the IEEE Engineering in Medicine and Biology Society, Jan. '95 - Dec. '99 and Jan. '02–Dec. '04.
Chairman, IEEE/EMBS Distinguished Lecturers Committee, 1997-1999.
Chairman, IEEE/EMBS Awards Committee, 2001-2002.
Chairman, IEEE/EMBS Fellow Committee, 2003-
Member of the IEEE/EMBS Publications Committee, 1995-1999, 2002-
Member of the IEEE/EMBS Finance Committee, 1995-1999, 2002-
Member, *IEEE Transactions on Biomedical Engineering* Editor-in-Chief Search Committee, 1996.
Member, *IEEE Transactions on Biomedical Engineering* Editor-in-Chief Search Committee, 2000.
Member of the IEEE Fellow Committee, 1998-2001.
President-Elect of the IEEE Engineering in Medicine and Biology Society (EMBS), 2004.

Awarded the Early Career Achievement Award of the IEEE Engineering in Medicine and Biology Society for his contributions to the fields of medical imaging, signal processing for biomedical applications, electrical impedance tomography and tissue modeling, Nov. 1988.

Co-Chaired the session, "Microprocessor-based instrumentation: hardware and software" in the Fifth Annual IEEE/EMBS Conference, Sept. 1983.

Organized and chaired the session, "Electrosurgery and Dispersive Electrodes," in the AAMI 19th Annual Meeting in Washington, D.C., April 1984.

Organized and presented the 3-hour workshop, "Advanced Microprocessors for Biomedical Engineering Applications," in the Sixth Annual IEEE/EMBS Conference in Los Angeles, Sept. 1984.

Chaired the session, "System Architecture," in Mini and Microcomputers in Control, Filtering and Signal Processing Conference, in Las Vegas, Dec. 1984.

Organized and chaired the session "Biomedical Image Processing Computer Systems," in the Seventh Annual IEEE/EMBS Conference in Chicago, Sept. 1985.

Organized and taught a short course, "Computer Hardware/Software Systems for Image Processing," in the Seventh Annual IEEE/EMBS Conference in Chicago, Sept. 1985.

Member of the technical program committee for the Seventh Annual IEEE/EMBS Conference in Chicago, Sept. 27-30, 1985.

Chaired the session "Image Processing/Pattern Recognition," in the Software and Hardware Applications of Microcomputers Conference in Beverly Hills, CA, Feb. 5-7, 1986.

Member of the international program committee for the Software and Hardware Applications of Microcomputers Conference in Beverly Hills, CA, Feb. 5-7, 1986.

Chaired the session, "Image Processing V," in the SPIE Medical Imaging Conference in Newport Beach, CA, Feb. 1-6, 1987.

Finance Chairman of the 1987 Workshop on Computer Architecture for Pattern Analysis and Machine Intelligence, Oct. 5-8, 1987.

Co-Chaired the session, "Image Processing," in the Washington Exhibition of Science and Technology (WEST-88), Oct. 1988.

Chaired the session, "Image Processing II," in the Tenth Annual IEEE/EMBS Conference in New Orleans, Nov. 1988.

Member of the organizing committee for the First International Conference on Image Management and Communication in Patient Care: Implementation and Impact (IMAC-'89), Washington, D.C., June 1989.

Chaired the Image Technology Workshop in the IMAC-'89 Conference, Washington, D.C., June 1989.

Program Chairman of the Eleventh Annual International Conference of the IEEE/EMBS (in charge of organizing more than 1,000 papers, 180 sessions, 23 tracks), Nov. 1989. Acknowledged by the IEEE/EMBS President, "for his perception of quality and his unflagging dedication to produce a comprehensive and outstanding technical program for the 1989, 11th Annual International Conference of the IEEE/EMBS".

Chairman of the Bioelectric Potentials Track with 8 sessions in the Eleventh Annual International Conference of the IEEE/EMBS, Nov. 1989.

Member of the IEEE TAB (Technical Activities Board) New Ventures Committee, 1990.

Member of the Program Committee for the SPIE Medical Imaging Conference in Newport Beach, CA, Feb. 1990.

Chaired the session, "Workstations," in the SPIE Medical Imaging Symposium in Newport Beach, CA, Feb. 1990.

Conference Co-Chairman of the SPIE Medical Imaging Symposium (in charge of Image Capture and Display Conference, Vol. 1232) in Newport Beach, CA, Feb. 1990.

Chaired the workshop, "Image Computing Systems," at the UW College of Engineering Corporate Associates Day, Seattle, WA, April 1990.

Chaired the session, "Image Processing," in the Twelfth Annual International Conference of the IEEE/EMBS, Nov. 1990.

Member of the SPIE Medical Imaging Technical Organizing Committee for the 1991 Conference in San Jose, CA, Feb. 1991.

Chairman of the SPIE Image Capture, Formatting, and Display Conference in San Jose, CA, Feb. 1991.

Chaired the session, "Workstations," in the SPIE Medical Imaging Conference in San Jose, CA, Feb. 1991.

Member of the organizing committee for the Second International Conference on Image Management and Communication in Patient Care: New Technology for Better Patient Care (IMAC-'91), Kyoto, Japan, April 1991.

Presented a 3-hour minicourse, "Advances in Image Processing ICs," in the Electronic Imaging West '91 Conference in Anaheim, CA, April 1991.

Chaired the session, "Parallel Processing," in the IEEE Pacific Rim Conference on Communications, Computers and Signal Processing, Victoria, B.C., May 1991.

Selected as one of the IEEE/EMBS Distinguished Lecturers, 1991.

Presented a 3-hour minicourse, "Advances in Image Processing ICs," in the Electronic Imaging East '91 Conference in Boston, MA, Sept. 1991.

Chairman of the SPIE Image Capture, Formatting, and Display Conference in Newport Beach, CA, Feb. 1992.

Organized and was keynote speaker of a workshop, "Medical Imaging Workstations" at the SPIE Medical Imaging VI in Newport Beach, CA, Feb. 1992.

Chaired the session, "New ICs for Image Processing," in the Electronic Imaging West '92 Conference in Anaheim, CA, March 1992.

Presented a 3-hour minicourse, "Advances in Image Processing ICs," in the Electronic Imaging West '92 Conference in Anaheim, CA, March 1992.

Member of the NIH site visit team to the Bowman Gray Medical Center, Winston Salem, NC, March 1992.

Chaired the session, "Workstations," in the Symposium for Computer Assisted Radiology (S/CAR) in Baltimore, MD, June 1992.

Member of the NSF Proposal Review Panel, Washington, D.C., Sept. 1992.

Member of the ABET Accreditation Visit Team to University of Texas at Austin, Oct. 1992.

Member of the Conference Committee for the IEEE/EMBS 14th Annual International Conference, Paris, France, Oct. 1992.

Exhibit Co-Chair for the IEEE/EMBS 14th Annual International Conference, Paris, France, Oct. 1992.

Co-Chair of the PACS topic area for the IEEE/EMBS 14th Annual International Conference, Paris, France, Oct. 1992.

Invited speaker at the "Tutorials: Frontiers of Computers in Biomedical Engineering" during the IEEE/EMBS 14th Annual International Conference, Paris, France, Oct. 1992.

Chairman of the SPIE Image Capture, Formatting, and Display Conference in Newport Beach, CA, Feb. 1993.

Organized and was keynote speaker of a workshop, "Multimedia Systems in Medicine" at the SPIE Medical Imaging VII in Newport Beach, CA, Feb. 1993.

Member of the NSF-sponsored Planning Workshop on Computer Assisted Surgery, Washington, D.C., Feb. 1993.

Member of the ABET Accreditation Visit Team to University of Missouri-Columbia, Oct. 1993.

Chairman of the SPIE Image Capture, Formatting, and Display Conference, and chaired a session on "Multimedia in Medical Imaging" in Newport Beach, CA, Feb. 1994.

Organized and chaired the workshop, "Virtual Reality Applications in Medicine" at the SPIE Medical Imaging Conference in Newport Beach, CA, Feb. 1994.

Invited speaker at the CeBit Conference in Hannover, Germany, March 22, 1994.

Member of the International Advisory Board for the IEEE-EMBS International Summer School on 3-Dimensional Biomedical Imaging, Univ. de Rennes, France, July 2-10, 1994.

Member of the Program Committee for the First International Symposium on Medical Robotics and Computer Assisted Surgery, Pittsburgh, PA, Sept. 1994.

Invited speaker at the SPIE Critical Review on Defining the Global Information Infrastructure, Boston, MA, Nov. 1994.

External reviewer of the graduate program on Biomedical Physics at UCLA, Nov. 1994.

Member of the ABET Accreditation Visit Team to Northwestern Polytechnic University, Nov. 1994.

Chairman of the Image Display Conference, SPIE Medical Imaging, San Diego, CA, Feb. 1995.

Chair of the session, "Issues in Image Displays," SPIE Medical Imaging Conference, San Diego, CA, Feb. 1995.

Organized and chaired the workshop, "Multimedia Applications in Telemedicine," SPIE Medical Imaging Conference, San Diego, CA, Feb. 1995.

Invited speaker at the AAAS Workshop on Fundamental Issues of Imaging Science, Atlanta, GA, Feb. 16-17, 1995.

Invited speaker at the National Forum: Military Telemedicine On-Line Today, "Research, Practice and Opportunities," McLean, VA, March 1995.

Chair of the session on "Desktop Video Conferencing: Chips, Boards and Applications" at the DSP_X '95 Conference, San Jose, CA, May 15-18, 1995.

Tutorial on Multimedia Technologies and Systems at the IEEE International Conference on Communications, Seattle, WA, June 22, 1995.

Member of the Program Committee for the Fourth International Conference on Image Management and Communication (IMAC 95), Oahu Island, Hawaii, August 1995.

Organized and chaired the one-day TMS320C80 Developers' Conference at the University of Washington, Sept. 15, 1995.

Member of the Program Committee for the SPIE 1995 Symposium on Information, Communications and Computer Technology, Applications and System, Philadelphia, PA, Oct. 1995.

Member of the Program Committee for the Second International Symposium on Medical Robotics and Computer Assisted Surgery, Baltimore, MD, Nov. 1995.

External Reviewer for the Biomedical Imaging Program at University of Virginia, Charlottesville, Nov. 1995.

Chairman of the Image Display Conference, SPIE Medical Imaging, Newport Beach, CA, Feb. 1996.

Organized the workshop, "Multimedia and Information Superhighway in Telemedicine," SPIE Medical Imaging, Newport Beach, CA, Feb. 1996.

Chair of the session, "Multimedia, Virtual Reality, and Telemedicine," SPIE Medical Imaging Conference, Newport Beach, CA, Feb. 1996.

Member of the NIH site visit team to the University of Texas Health Science Center at San Antonio, July 1996.

Member of the Technical Program Committee for the 1996 International Conference on Image Processing, Lausanne, Switzerland, Sept. 1996.

Chairman of the Image Display Conference, SPIE Medical Imaging, Newport Beach, CA, Feb. 1997.

Chair of the session, "Three-Dimensional Visualization Systems," SPIE Medical Imaging, Newport Beach, CA, Feb. 1997.

Chair of the session, "Multimedia in Real-Time Medical Image Computing," SPIE Medical Imaging, Newport Beach, CA, Feb. 1997.

Member of the Program Committee for the 1st Joint Conference of CVRMED II and MRCAS III, Grenoble, France, March 1997.

Member of the NIH site visit team to the University of Utah, Salt Lake City, UT, July 1997.

Member of the International Advisory Board for the Information Technology Applications in Biomedicine Conference, Prague, Czech Republic, Sept. 1997.

Chairman of the session, "Multimedia, Display, and Telemedicine," SPIE Medical Imaging, San Diego, CA, Feb. 1998.

Chairman of the session, "Image Hard and Soft Copies," SPIE Medical Imaging, San Diego, CA, Feb. 1998.

Chairman of the Image Display Conference, SPIE Medical Imaging, San Diego, CA, Feb. 1998.

Chairman of the SPIE Medical Imaging Symposium, San Diego, CA, Feb. 1998.

Co-Chairman of the Image Display Conference, SPIE Medical Imaging, San Diego, CA, Feb. 1999.

Chairman of the SPIE Medical Imaging Symposium, San Diego, CA, Feb. 1999.

Session Chair at the IEEE/EMBS, Atlanta, GA, Oct. 1999.

Chairman of the SPIE Medical Imaging Symposium, San Diego, CA, Feb. 2000.

Chairman of the session on "Image Guided Procedures II," at the SPIE Medical Imaging, San Diego, CA, Feb. 2000.

Member of the ABET Accreditation Visit Team to Marquette University, Milwaukee, Oct. 2000.

Chairman of the SPIE Medical Imaging Symposium, San Diego, CA, Feb. 2001.

Chairman of the session on "Clinical Applications I," at the SPIE Medical Imaging, San Diego, CA, Feb. 2001.

Member of the ABET Accreditation Visit Team to University of California, San Diego, Oct. 2001.

Co-Chair of the workshop on Entrepreneurship and Technology Transfer at the Whitaker Foundation Biomedical Engineering Research Conference, San Diego, CA, August 2002.

Co-Chair of the workshop on Industry-Sponsored Research at the Whitaker Foundation Biomedical Engineering Research Conference, San Diego, CA, August 2002.

Co-Chair of the Imaging Theme in the IEEE/EMBS Annual Conference, Cancun, Mexico, Sept. 2003.

Session Chair at the IEEE/EMBS, Cancun, Mexico, Sept. 2003.

Member of the ABET Accreditation Visit Team to Boston University, Boston, Oct. 2003.

Co-Chair of the Healthcare Information Technology Theme in the IEEE/EMBS Annual Conference, San Francisco, Sept. 2004.

Chair of three sessions in the IEEE/EMBS Annual Conference, San Francisco, Sept. 2004.

Member of the Whitaker Foundation site visit team to Columbia University on 12/9/04.

Member of the Cleveland Clinic Foundation Department of Biomedical Engineering External Advisory Board since 1996.

Member of the University of Wisconsin Department of Biomedical Engineering External Advisory Board since 2000.

Member of the Electronic Imaging Technical Advisory Board, 1991-1992.

Member of the SDI Biomedical Technology Application Review Panel, 1992-1993.

Member of the Advisory Board & IEEE/EMBS Representative to the IEEE Transactions on PAMI (Pattern Analysis and Machine Intelligence), 1985-1995.

Member of the IEEE P610 Computer Dictionary Working Group since 1987.

Member of the Steering Committee for IEEE Transactions on Medical Imaging, 1990-1996.

Reviewed papers since 1982 for the *Proceedings of the IEEE, IEEE Transactions on Biomedical Engineering, IEEE Transactions on Pattern Analysis and Machine Intelligence, IEEE Transactions on Information Technology in Biomedicine, IEEE Transactions on Systems, Man, and Cybernetics, IEEE Transactions on Medical Imaging, IEEE Transactions on Ultrasonics, Ferroelectronics and Frequency Control, IEEE Transactions on Education, IEEE Micro, IEEE EMB Magazine, Optical Engineering, Computer Vision, Graphics, and Image Processing, Journal of Multimedia Tools and Applications, Telemedicine Journal, Real-Time Imaging, International Symposium on Computer Architecture, International Conference on Image Processing, International Journal of Microcomputer Applications, Investigative Radiology, Clinical Physics and Physiological Measurement, Health Devices, Journal of Microwave Power, Encyclopedia of Electrical and Electronics Engineering, and many textbooks.*

Consulting Practice

Consultant, DPMS, Kirkland, WA, 1984.
Consultant, Empirical Research Group, Federal Way, WA, 1984-1985.
Consultant, Samsung Electronics, Seoul, Korea, 1985.
Consultant, Northwest Research Associates, Bellevue, WA, 1985-1987.
Consultant, Levinson, Friedman, Vhugen, Duggan, Bland & Horowitz, Seattle, WA, 1986.
Consultant to review the Clinical Center, National Institutes of Health, Bethesda, MD, 1988.
Consultant, MITRE Corporation, McLean, VA, 1990.
Consultant, Electronics and Telecommunications Research Institute (ETRI), Taejon, Korea, 1988-1990.
Consultant, Neopath, Inc., Seattle, WA, 1989-1990, 1996.
Consultant, Lotte-Canon, Seoul, Korea, 1991.
Consultant, Trinus Partners, Seattle, WA, 1989-1991.
Consultant and member of the Technical Advisory Board, Seattle Silicon, Bellevue, WA, 1990-1991.
Consultant, Samsung Data Systems, Seoul, Korea, 1992.
Consultant, Intel Corporation, Chandler, AZ, 1992.
Consultant, APTEC, Portland, OR, 1992-1993.
Consultant and member of the Board of Directors, Optimedx, Seattle, WA, 1992-1996.
Consultant and member of Scientific Advisory Board, MicroVision Inc., Seattle, WA, 1994-1996.
Consultant, United States Army, 1989-1995.
Consultant, Siemens Medical Systems, Iselin, NJ, 1993-1996.
Consultant, Precision Digital Images Corp., Redmond, WA, 1994-1996.
Consultant, Hitachi, Tokyo, Japan, 1994-
Consultant, Canon, Tokyo, Japan, 1996-2000.
Consultant, Fujitsu, Tokyo, Japan, 1995-1996.
Consultant & member, Scientific Advisory Board, Cable & Howse Ventures, Bellevue, WA, 1995-1996.
Consultant, Perkins Coie, Seattle, WA, 1996.
Consultant, Georgetown University Medical Center, Washington, DC, 1995-2000.
Consultant & member, Scientific Advisory Board, Equator Technologies, Inc., Campbell, CA, 1994-
Consultant, Korean Ministry of Science and Technology, 1999-2000.
Consultant, Micron Technology, Boise, ID, 2000.
Consultant, LizardTech Inc., Seattle, WA, 2000.
Consultant, Amster, Rothstein & Ebenstein, New York, NY, 2000-2002.
Consultant, Streambox Inc., Seattle, WA, 2000-2001.
Consultant, McIntyre & Barns, Seattle, WA, 2001-2002.

Consultant, DNA Inc., Tokyo, Japan, 2001-
Consultant & member, Scientific Advisory Board, Encompass Ventures, Bellevue, WA, 2002-
Consultant, GAIO, Tokyo, Japan, 2002-
Consultant, White & Case, Paolo Alto, CA, 2002-

Patents

"Image Computing System," was filed in June 1990. Patent #5,355,443 was awarded in Oct. 1994.

"Imaging and Graphics Processing System," was filed in Aug. 1991. Patent #5,467,459 was awarded in Nov. 1995. A Korean patent was awarded as well.

"UWGSP4 (An Imaging and Graphics Superworkstation)," was filed in Aug. 1992. A European patent #EP0739513 was awarded in Oct. 1998.

"Ultrasound Signal Processing Apparatus," was filed in Feb. 1995. Patent #5,492,125 was awarded in Feb. 1996.

"Real-Time Ultrasound Scan Conversion," was filed in Aug. 1995. Patent #5,528,302 was awarded in June 1996.

"Method for Controlling the Operation of a Computer Implemented Apparatus to Selectively Execute Instructions of Different Bit Lengths," was filed in March 1993. Patent #5,511,174 was awarded in April 1996.

"Central Processing Unit Data Entering and Interrogating Device and Method Therefor," was filed in July 1993. Patent #5,561,761 was awarded in Oct. 1996.

"Ultrasound System for Automatically Measuring Fetal Head Size," was filed in March 1996. Patent #5,605,155 was awarded in Feb. 1997.

"Self-Defining Instruction Size," was filed in March 1993. Patent #5,673,409 was awarded in Sept. 1997.

"Ultrasound Imaging with Real-Time 3D Image Reconstruction and Visualization," was filed in Feb. 1997. Patent #5,787,889 was awarded in Aug. 1998.

"Pipeline Process for Automatically Measuring Fetal Head Size from Ultrasound Image Samples," was filed in Feb. 1997. Patent #5,795,296 was awarded in Aug. 1998.

"Real Time Color Doppler Ultrasound Imaging," was filed in Feb. 1997. Patent #5,910,117 was awarded in June 1999.

"Pubic Arch Detection and Interference Assessment in Transrectal Ultrasound Guided Prostate Cancer Therapy," was filed Nov. 1998. Patent #6,027,446 was awarded in Feb. 2000.

"Template Matching in 3 Dimensions Using Correlative Auto-Predictive Search," was filed in Dec. 1998. Patent #6,243,494 was awarded in June 2001.

"Color Clustering for Scene Change Detection and Object Tracking in Video Sequences," was filed in Jan. 1999. Patent #6,272,250 was awarded in Aug. 2001.

"Template Matching Using Correlative Auto-Predictive Search," was filed in Dec. 1998. Patent #6,301,387 was awarded in Oct. 2001.

"Motion Estimation within a Sequence of Data Frames Using Optical Flow with Adaptive Gradients," Patent #6,480,615 was awarded in Nov. 2002.

"Interactive Video Object Processing Environment having Zoom Window," Patent #6,525,746 was awarded in Feb. 2003.

"Image Processing in HIS Color Space using Adaptive Noise Filtering," Patent #6,535,632 was awarded in March 2003.

"Video Object Segmentation using Active Contour Modeling with Global Relaxation," Patent #6,546,117 was awarded in April 2003.

"Video Object Tracking Using a Hierarchy of Deformable Templates," Patent #6,574,353 was awarded in June 2003.

"Template Matching Using Correlative Auto-Predictive Search," Patent #6,584,224 was awarded in June 2003.

Patent #6,631,206 was awarded in October 2003.

Patent #6,633,309 was awarded in October 2003.

Patent #6,674,925 was awarded in January 2004.

Patent #6,675,286 was awarded in January 2004.

Patent #6,678,416 was awarded in January 2004.

Patent #6,681,043 was awarded in January 2004.

Patent #6,731,799 was awarded in May 2004.

Patent #6,732,247 was awarded in May 2004.

Patent #6,775,404 was awarded in August 2004.

Patent #6,779,101 was awarded in August 2004.

Patent #6,782,470 was awarded in August 2004.

Patent #6,785,743 was awarded in August 2004.

37 patents issued, about 35 patent applications (including international) are pending.

Invention Disclosures and Technology Transfers

1. Transferred the technology developed in my lab, "Hardware and software development for image processing and computer graphics in IBM PC/AT environment," to Indec Systems, Sunnyvale, CA, in Sept. 1987, through the Office of Technology Transfer of UW. Commercialized. About 500 systems have been sold for biomedical imaging applications including Zeiss confocal microscope's display systems.

2. Disclosed the technology developed in my lab, "An efficient user interface for the PC-based high-

performance imaging workstation," to the Office of Technology Transfer of UW in March 1988.

3. "A high-performance floating point PC-based imaging workstation," in May 1988.

4. "UWGSP3, a high-performance NeXT-based imaging & graphics workstation," in Dec. 1989. A patent application in U.S., Canada, Japan, Korea and Europe was filed and issued in U.S. (#5,355,443). This technology was transferred to Daewoo Telecom Co. in March 1990. Commercialized. About 20 systems have been sold for high-end imaging applications.

5. "UWGSP3-HI: Host-independent image computing workstation," in Sept. 1990.

6. "UWGSP4: An imaging and graphics supercomputer," in Sept. 1990. A patent application in U.S., Japan, Korea and Europe was filed and issued in U.S. (#5,467,459)and Europe (#739,513).

7. "Development of individually tailored 3D thorax models and its application in external and internal defibrillation," in Aug. 1991.

8. "UWGPX: University of Washington graphics accelerator," in April 1991. Three patents were filed in 1993 and subsequently issued (#5,511,174, #5,561,761, and #5,673,409). This technology was transferred to VLSI Technology in 1992.

9. "MultiPlanar Display (MPD) system for image-guided surgery," in Sept. 1992.

10. "GSP5SIM: A simulation environment for MVP-based systems," in June 1993. This technology was transferred to Texas Instruments in Dec. 1993. Commercialized.

11. "UWGSP5: A programmable highly-integrated multimedia system with 2 billion operations per second computing performance," in Nov. 1993. This technology was transferred to Precision Digital Images, and GoldStar in early 1994. Commercialized. About 3000 systems have been sold around the world in imaging and multimedia.

12. "UWGSP8: Development of Image Computing Technologies and their Applications in Ultrasound Imaging," in April 1994. This technology was transferred to Siemens Medical Systems. A patent application in U.S. and Germany was filed and issued in U.S. (#5,492,125). Commercialized. Thousands of our system have been sold.

13. "UW MPEG-1 Codec," in July 1994. This technology was transferred to Radius (Oct. 1994) and Texas Instruments (Jan. 1995). Texas Instruments has sublicensed this to other companies.

14. "Library of Image Computing Routines for Multimedia Video Processor (MVP)" in July 1994. Based on this invention and our continuing R&D efforts, we set up an industry consortium on the UW Image Computing Library in Jan. 1995. So far, eight commercial licenses have resulted from this invention

15. "An Efficient Scan Conversion Algorithm for Ultrasound Machines" in Jan. 1995. A patent application was filed and issued (#5,528,302).

16. "UWGSP7: A Microcomputer-Based System for Real-Time Optical Imaging," in April 1995.

17. "Automatic Fetal Head Size Measurements form Ultrasound Images Using Image Processing Techniques," in Aug. 1995. A patent application was filed and issued (#5,605,155). Commercialized.

18. "MPM: MVP Performance Monitor," in Dec. 1995.

19. "PPS: TMS320C80 Loop Scheduler," in Dec. 1995.

20. "The University of Washington Image Computing Library for HMPV (High-performance Multimedia Processor using VLIW)," in June 1996. Licensed to Hitachi and Xerox.

21. "Interactive Automatic Fetal Head Boundary Detection from Ultrasound Images," in Oct. 1996. A patent application was filed and issued (#5,795,296).

22. "An Efficient Fast Fourier Transform Algorithm for Superscalar and VLIW Processor Architectures," in Oct. 1996.

23. "A Real-Time Algorithm for Generating Color Doppler Ultrasound Images on Programmable Processors," in Oct. 1996. A patent application was filed and issued (#5,910,117).

24. "A Real-Time Three-Dimensional Ultrasound System," in Oct. 1996. A patent application was filed and issued (#5,787,889). Commercialized.

25. "A PC-Based Machine Vision System for Real-Time Computer-Aided Inspection," in Dec. 1996.

26. "Efficient Implementation of Image Warping on a Multimedia Processor," in Dec. 1996.

27. "A Real-Time Color Flow Processing Algorithm on Commercially-Available Microprocessors," in Sept. 1997. A patent application was filed.

28. "Automatic Pubic Arch Detection to Assess the Pubic Arch Interference," in Sept. 1997. A patent application was filed and issued (#6,027,446). Commercialized.

29. "Extended Data Cache Prefetching Using A Reference Prediction Table," in Sept. 1997.

30. "Prostate Boundary Detection and Volume Measurement," in Feb. 1998. A patent application was filed.

31. "Template Matching With Using Correlation Auto-Predictive Search (CAPS)," in April 1998. A patent application in U.S., Japan and Europe was filed and issued in U.S. (#6,301,387). Licensed.

32. "Lossy Compression of Pre-Scan Converted Ultrasound Sequences," in April 1998.

33. "ProSeed: A Tool to Count Seeds in Post-Implant CT Images After Prostate Brachytherapy Treatment," in April 1998.

34. "Template Matching Using Three-Dimensional Correlation Auto-Predictive Search (3D-CAPS)," in April 1998. A patent application in U.S., Japan and Europe was filed and issued in U.S. (#6,243,494). Licensed.

35. "Modified Continuous-Valued Adaptive Resonant Theory (M-ART2) for Color Clustering and Scene Change Detection in Video Sequences," in June 1998. A patent application in U.S., Japan and Europe was filed and issued in U.S. (#6,272,250). Licensed.

36. "Active Contour with Global Relaxation in Video Object Segmentation and Tracking," in Sept. 1998. A patent application in U.S., Japan and Europe was filed. Licensed.

37. "Template Matching Using Multiple-Step CAPS," in Sept. 1998. Licensed. (Incorporated into #31, & #34).

38. "Motion Estimation based on Optical Flow with Adaptive Gradients," in Nov. 1998. A patent application in U.S., Japan and Europe was filed and issued (#6,480,615). Licensed.

39. "An Extensible Framework for Interactive Video Segmentation and Compression," in Dec. 1998. A patent application in U.S., Japan and Europe was filed.

40. "Adaptive Noise Filtering in HSI Color Space," in Dec. 1998. A patent application was filed.

41. "Video Object Tracking in MPEG-4 with a Hierarchy of Deformable Templates," in Jan. 1999. A patent application in U.S., Japan and Europe was filed.

42. "Multimedia Instruction Set for Wide Datapaths," in Feb. 1999. A patent application was filed.

43. "Using Motion-Compensated Frame-Rate Conversion for the Correction of 3:2 Pulldown Artifacts in Video Sequences," in Feb. 1999.

44. "Subinstruction Sharing in VLIW Architectures," in Feb. 1999. A patent application was filed.

45. "Interactive 3D Registration of Ultrasound and Magnetic Resonance Images based on a Magnetic Position Sensor," in Feb. 1999.

46. "Three-dimensional Ultrasound Extended Field of View (3D-XFOV): A Method for Evaluating Large Volumes," in Feb. 1999.

47. "Fast Calibration for 3D Ultrasound Imaging and Multimodality Image Registration," in April 1999.

48. "Template Data Transfer Coprocessor for Mediaprocessors," in May 1999. A patent application was filed.

49. "Postprocessing with Morphology to Improve Object Tracker Robustness," in May 1999. A patent application was filed.

50. "Video Object Segmentation and Tracking Using Vsnakes with Automatic Local Affine Deformation," in May 1999. A patent application in U.S., Japan and Europe was filed.

51. "simCore: A Simulation Library for Efficient Cycle-Accurate Computer System Simulation," in June 1999.

52. "Opcode Compression," in June 1999. A patent application was filed.

53. "Edge Guidance Outlining of Prostate Ultrasound Images with Just-Enough-Interaction," in June 1999.

54. "Generalized Filtering Operations for Hue Image," in July 1999. A patent application was filed.

55. "Architecture and Algorithms for a Fully Programmable Ultrasound Machine," in Aug. 1999.

56. "Transposable Register File," in Aug. 1999. A patent application was filed.

57. "Active Contour Model with Gradient Directional Information: Directional Snake," in Aug. 1999. A patent application in U.S. and Japan was filed.

58. "Vsnakes with Boundary Propagation," in Nov. 1999. A patent application in U.S., Japan and Europe was filed.

59. "Interactive Frame Segmentation with Dynamic Programming," in Jan. 2000. A patent application was filed.

60. "Multi-ported Pipelined Memory," in Jan. 2000. A patent application was filed.

61. "Operand Queues for Streaming Data: A Register File Extension," in Feb. 2000. A patent application was filed.

62. "Ultrasound Image Contrast Enhancement via Integrating Transducer Position Information," in Feb. 2000.

63. "A Framework for Internet-based Home Telemedicine Systems with Multimedia Capabilities," in Feb. 2000.

64. "Video Object Tracking via Background Estimation and Subtraction," in March 2000. A patent application was filed.

65. "Program-directed Cache Prefetching for Mediaprocessors," in Aug. 2000. A patent application was filed.

66. "New Instructions and an Algorithm for Padding in MPEG-4," in Nov. 2000. A patent application was filed.

67. "Mediaprocessor Programming Interface to Increase the Portability of Mediaprocessor Software," in Dec. 2000.

68. "A Method for Boundary Macroblock Padding in an MPEG-4 Video Decoder Utilizing a Graphics Coprocessor," in Jan. 2001. A patent application was filed.

69. "A Programmable 3D Graphics Pipeline for Multimedia Applications," in Feb. 2001. A patent application was filed.

70. "Programmable Ultrasound Scan Conversion on a Mediaprocessor-based System," in Mar. 2001.

71. "A Method to Better Utilize Deep-Pipelined Architectures by Eliminating Setup and Pipeline Delays," in Jan. 2002.

72. "University of Washington Image Computing Library for Texas Instruments TSM320C64x," in May 2002.

73. "Adaptive Clutter Filtering for Ultrasound Color Flow Imaging," in Dec. 2002.

74. "Personal Health Information Management System and Facilitated Accurate Referral management," in March 2003.

75. "Architecture and Algorithms for a Programmable Ultrasound Machine," in June 2003. Licensed.

76. "Transcutaneous Localization of Internal Bleeding by Two-dimensional Ultrasonic Imaging of Tissue Vibrations," in Oct. 2003.

77. "Method and Apparatus for a Low-cost, Reconfigurable, and Programmable Receive Beamformer," in Jan. 2004.

78. "Ultrasound Imaging Method and Apparatus using Coded Excitation with Efficient Transmit Power Coding and 2-Stage Pulse Compression," in Feb. 2004.

79. "Method and Apparatus for a Home Ultrasound System," in Feb. 2004.

80. "Ultrasound Technique for Assessing Wall Vibrations in Stenosed Arteries," in March 2004.

Professional Presentations

Guest speaker on 2/5/83 at the Tau Beta Pi Initiation Banquet, South Campus HUB, UW.

Seminar on 7/2/84 at Purdue University, West Lafayette, IN.

Invited speaker in the tutorial, "Medical Applications of Microprocessors," in the AAMI Regional Meeting in Portland, OR, October 1-3, 1984.

Seminar on 10/12/84 at Electrical Engineering EE 599B, UW.

Seminar on 11/21/84 at Bioengineering BIOEN 510, UW.

Seminar on 5/6/85 at Seoul National University, Seoul, Korea.

Seminar on 5/7/85 at KAIST (Korean Advanced Institute of Science and Technology), Seoul, Korea.

Seminar on 11/13/85 at Bioengineering BIOEN 510, UW.

Presentation on 11/14/85 at "A Symposium in Instructional Computing", UW.

Seminar on 12/2/85 at Sheffield University, Sheffield, England.

Seminar on 12/5/85 at University of Duisburg, Duisburg, West Germany.

Seminar on 3/31/86 at Department of Aeronautics and Astronautics, UW.

Seminar on 4/15/86 at Northwestern University, Evanston, IL.

Seminar on 4/17/86 at MIT, Cambridge, MA.

Seminar on 4/18/86 at National Institutes of Health, Bethesda, MD.

Invited speaker at the Conference, "Medical Bioelectric Impedance - State of the Art, Indianapolis, IN, June 13-14, 1986.

Seminar on 6/16/86 at University of Illinois, Urbana-Champaign, IL.

Seminars on 6/30/86 and 7/1/86 at University of Nantes, Nantes, France.

Invited speaker at the European Community Workshop on Electrical Impedance Imaging in Sheffield, England, July 2-4, 1986.

Seminar on 9/29/86 at Electrical Engineering EE 590D, UW.

Seminar on 10/29/86 at Bioengineering BIOEN 510, UW.

Seminar on 11/20/86 at Department of Computer Science, UW.

Seminar on 1/13/87 at B. C. Cancer Research Center, Vancouver, Canada.

Seminar on 2/2/87 at Electrical Engineering EE 599B, UW.

Seminar on 2/12/87 at University of California, Irvine, CA.

Seminar on 3/25/87 at AT&T Bell Laboratories, Middletown, NJ.

Invited speaker on 6/10/87 at the Texas Instruments 1987 Graphics Solution Seminar, Bellevue, WA.

Invited speaker in the Continuing Medical Education Course, "Computer Graphics in Medicine and Surgery," Virginia Mason Medical Center, Seattle, WA, June 26, 1987.

Invited speaker in Electrical Engineering Symposium at the IBM ACIS University Conference in Boston, June 27-30, 1987.

Demonstrated the image processing workstation (UWGSP#1) developed in my lab at the IBM ACIS University Conference in Boston, June 28-29, 1987.

Demonstrated UWGSP#1 at the Siggraph '87 Conference in Anaheim, CA, July 28-30, 1987.

Demonstrated UWGSP#1 at the Annual Review of Neurosurgery in Seattle, WA, Oct. 15-17, 1987.

Demonstrated UWGSP#1 at the COMDEX Fall '87 Conference in Las Vegas, Nov. 3-4, 1987.

Invited speaker at the IBM Conference on Academic Computing, Berkeley, CA, Nov. 14, 1987.

Seminar on 11/13/87 at IBM Scientific Center, Palo Alto, CA.

Seminar on 11/16/87 at BBN Laboratories, Cambridge, MA.

Seminar on 12/1/87 at Bioengineering BIOEN 299, UW.

Seminar on 1/25/88 at Electrical Engineering EE500B, UW.

Seminar on 1/28/88 at University of Virginia, Charlottesville, VA.

Seminar on 2/24/88 at Bioengineering BIOEN 510, UW.

Invited speaker at the IEEE Computer Society of United Kingdom and Republic of Ireland Chapter Meeting on Computing in Medicine, March 3, 1988, Imperial College, London, England.

Demonstrated UWGSP#1 at the Reception featuring authors of University-sponsored software and their products in Seattle, WA, March 17, 1988.

Presentation at the UW College of Engineering Visiting Committee, April 21, 1988.

Seminar on 5/18/88 at the Harborview Medical Center, Seattle, WA.

Seminars on 6/20, 6/21 and 6/22/88 at ETRI (Electronics and Telecommunications Research Institute), Taejon, Korea.

Seminar on 6/23/88 at Yonsei University, Seoul, Korea.

Seminar on 6/24/88 at Seoul National University Hospital, Seoul, Korea.

Seminar on 6/25/88 at KAIST (Korean Advanced Institute of Science and Technology), Seoul, Korea.

Seminar on 7/6/88 at POSTECH (Pohang Institute of Science & Technology), Pohang, Korea.

Seminar on 7/8/88 at Seoul National University Department of Computer Engineering, Seoul, Korea.

Seminar on 7/11/88 at Sony Research Center, Tokyo, Japan.

Seminar on 7/12/88 at Toshiba Medical Engineering Laboratory, Otawara, Japan.

Demonstrated the floating-point image processing workstation (UWGSP#2) developed in my lab at the Siggraph '88 Conference in Atlanta, GA, Aug. 2-4, 1988.

Seminar on 8/19/88 at University of Wisconsin, Madison, WI.

Seminar on 9/26/88 at Electrical Engineering EE500B, UW.

Invited speaker in the Image Processing Session of the Washington Exhibition of Science and Technology (WEST-88), Oct. 17, 1988.

Seminar on 11/15/88 at Bioengineering BIOEN 299, UW.

Seminar on 12/1/88 at Texas Instruments Central Research Lab, Dallas, TX.

Seminar on 1/25/89 at Bioengineering BIOEN 510, UW.

Presentation on 2/28/89 at the Computer Science Annual Affiliate Day, UW.

Seminar on 3/22/89 at KAIST (Korean Advanced Institute of Science and Technology), Seoul, Korea.

Invited speaker on 4/4/89 at the Duke University's NSF Engineering Research Center for Emerging Cardiovascular Technologies' Spring Workshop, Durham, NC.

Seminar on 4/13/89 at University of Southern California, Los Angeles, CA.

Seminar on 4/21/89 at University of Arizona, Tucson, AZ.

Seminar on 5/25/89 at Department of Computer Science CS 599, UW.

Seminar on 9/21/89 at ETRI (Electronics and Telecommunications Research Institute), Taejon, Korea.

Seminar on 9/25/89 at Electrical Engineering EE500B, UW.

Invited speaker on 10/31/89 at Lawrence Berkeley Lab in the Imaging Symposium, Berkeley, CA.

Invited speaker on 11/7/89 at University of Victoria in the Executive Symposia on Telehealth, Victoria, B.C.

Invited speaker on 11/14/89 at the Technology Transfer Breakfast, Rainier Club, Seattle, WA.

Demonstrated the UWGSP3 System developed in my lab at the SPIE Medical Imaging in Newport Beach, CA, Feb. 4-9, 1990.

Seminar on 2/26/90 at Electrical Engineering EE500B, UW.

Seminar on 3/7/90 to the Radiology Faculty, UW.

Seminar on 3/13/90 at KAIST (Korean Advanced Institute of Science and Technology), Seoul, Korea.

Seminar on 3/15/90 at ETRI (Electronics and Telecommunications Research Institute), Taejon, Korea.

Demonstrated the UWGSP3 System at the UW Computer Fair in Seattle, WA, March 14-15, 1990.

Demonstrated the USGSP3 System at the National Computer Graphics Association (NCGA) '90 Conference in Anaheim, CA, March 19-22, 1990.

Seminar on 3/23/90 at NeXT, Redwood City, CA.

Held a Press Conference on 3/29/90 on the UWGSP3 System at the University of Washington, Seattle, WA.

Seminar on 4/5/90 at Department of Computer Science and Engineering, UW.

Seminar on 4/16/90 at Boeing, Bellevue, WA.

Presentation on 4/19/90 at the UW College of Engineering Corporate Associate Day, Seattle, WA.

Seminar on 4/24/90 at the MIT Media Lab, Cambridge, MA.

Seminar on 4/25/90 at Naval Research Laboratory, Washington, D.C.

Seminar on 4/26/90 at IBM, Atlanta, GA.

Demonstrated the UWGSP3 System on 4/27 - 4/28/90 at UW Engineering Open House, Seattle, WA.

Seminar on 5/8/90 at Boeing, Kent, WA.

Seminar on 5/25/90 at the University of Washington Medical Center, UW.

Demonstrated the UWGSP3 System at COMDEX '90 Spring in Atlanta, GA, June 3-6, 1990.

Seminar on 6/12/90 at the 3M Advanced Media and Systems Center, St. Paul, MN.

Invited speaker on 6/12/90 at the Univ. of Minnesota Supercomputer Institute, Minneapolis, MN.

Seminar on 6/13/90 at the Physio Control Workshop on Electric Current Pathways in the Human Thorax, Silverdale, WA.

Seminar on 7/2/90 at ETRI (Electronics and Telecommunications Research Institute), Taejon, Korea.

Seminar on 7/4/90 at the Riviera Hotel, Taejon, Korea.

Seminar on 7/4/90 at KAIST (Korean Advanced Institute of Science and Technology), Seoul, Korea.

Seminar on 7/5/90 at Seoul National University, Seoul, Korea.

Held a Press Conference on 7/6/90 on the UWGSP3 system at the Hilton Hotel, Seoul, Korea.

Demonstrated the UWGSP3 System at the Siggraph '90 Conference in Dallas, TX, Aug. 7-9, 1990.

Seminar on 8/10/90 at Texas Instruments Central Research Laboratory, Dallas, TX.

Keynote speaker on 9/22/90 at the general assembly of the Korean Association of Physicists in Medicine, Seoul, Korea.

Seminar on 10/1/90 at Electrical Engineering EE500B, UW.

Demonstrated the UWGSP3 System at the UW Engineering Homecoming Open House & Tailgate Party on 10/27/90, and at the UW College of Engineering Annual Scholarship/Fellowship Awards Reception on 11/20/90.

Seminar on 11/7/90 at the Statistics Visualization Seminar Series, UW.

Invited speaker at the InCom '90 International Workshop, Nov. 28-29, 1990, Taejon, Korea.

Seminar on 2/28/91 at Siemens Ultrasound, San Ramon, CA.

Grand Round speaker at the Department of Laboratory Medicine of the University of Washington Medical Center, March 13, 1991.

Seminar on 3/28/91 at Seoul National University, Seoul, Korea.

Invited speaker at the IBM Medical Imaging Workshop, March 29-30, 1991, Seoul, Korea.

Seminar on 4/1/91, Korea Telecommunications Authority, Seoul, Korea.

Seminar on 4/3/91, Chungnam National University, Taejon, Korea.

Seminar on 4/8/91, Sony Central Research Lab, Tokyo, Japan.

Seminar on 4/9/91, Oki Electric Industry, Tokyo, Japan.

Seminar on 4/10/91, IBM-Japan, Tokyo, Japan.

Invited speaker at the Second International Conference on Image Management and Communication in Patient Care: New Technology for Better Patient Care (IMAC- '91), April 10-13, 1991, Kyoto, Japan.

Seminar on 5/17/91, Department of Radiology, UW.

Invited speaker at the Strategic Defense Initiative (SDI) Technology Transfer Forum, May 21-22, 1991, Washington, DC.

Seminar on 5/28/91, Korea Institute of Construction Technology, Seoul, Korea.

Seminar on 5/31/91, Asan Medical Center, Seoul, Korea.

Invited speaker at the Multimedia Computing Technology Workshop, May 29-30, 1991, Seoul, Korea.

Seminar on 6/25/91, Institute of Systems Science, National University of Singapore, Singapore.

Seminar on 6/27/91, Institute of Systems Science, National University of Singapore, Singapore.

Invited speaker on 7/1/91, IEEE Computer Chapter Hong Kong Section, Hong Kong.

Seminar on 7/5/91, Advanced Defense Development, Taejon, Korea.

Seminar on 7/8/91, POSTECH (Pohang Institute of Science & Technology), Pohang, Korea.

Visiting Professor for 7/8 - 7/10/91 at POSTECH, Pohang, Korea.

Presentation on 9/14/91, Dr. John W. Loop Memorial Lecture, UW.

Invited Speaker at the International Conference on Computers in Clinical Dentistry, 9/27/91 - 9/29/91, Houston, TX.

Seminar on 10/1/91, IBM T. J. Watson Laboratory, Hawthorne, NY.

Saturday Morning Pre-football Game Seminar on "Images of the 21st Century," 10/12/91, UW University Relations.

Seminar on 10/21/91 at Electrical Engineering EE500B, UW.

Invited speaker on 11/1/91 at the Symposium on Medical Informatics during the IEEE/EMBS 13th Annual International Conference, Orlando, FL.

Invited speaker on 11/5/91 at the IEEE/EMBS Seattle Chapter Meeting, Seattle, WA.

Seminar on 2/18/92 at the HP Laboratories, Palo Alto, CA.

Seminar on 3/10/92 at UCLA, Los Angeles, CA.

Invited speaker on 3/11/92 at the National Computer Graphics Association (NCGA) Conference, Anaheim, CA.

Seminar on 3/20/92, Seoul National University, Seoul, Korea.

Seminar on 4/20/92 at Electrical Engineering EE500B, UW.

Seminar on 4/30/92, Eta Kappa Nu Lecture Series, UW.

Invited speaker on 5/5/92 at the Opening Ceremonies for the New Diagnostic Imaging Sciences Center (DISC), UW.

Seminar on "Multimedia Algorithms, Chips and Systems" during 9/30/92-10/2/92, Intel Corporation, Chandler, AZ.

Seminar on 10/9/92, GoldStar Central Research Lab, Seoul, Korea.

Invited Speaker and Session Chair on 10/14/92 at the Korean Federation of Sciences & Technology

Society's Fall Workshop on Medical Imaging, Seoul, Korea.

Keynote speaker on 11/3/92 for Cadence's Top-Down Design Seminar, Kirkland, WA.

Seminar on 11/9/92 at Electrical Engineering EE500B, UW.

Seminar on 11/10/92, Siemens Medical Systems, Issaquah, WA.

Seminar on 1/4/93 at Electrical Engineering EE500B, UW.

Seminar on 1/11/93 at Electrical Engineering EE500B, UW.

Invited speaker on 4/29/93 at the IEEE Oregon Section Meeting, Portland, OR.

Seminar on 7/8/93, Siemens Corporate Research, Princeton, NJ.

Visiting Professor from 11/22/93 - 11/26/93 at the University of Nantes, Nantes, France.

Seminar on 12/6/93 at Electrical Engineering EE500B, UW.

Seminar on 2/7/94 at Electrical Engineering EE500B, UW.

Seminar on 2/11/94 at Sony, San Diego, CA.

Presentation and demo of MediaStation 5000 on 2/13-2/14/94 at SPIE, Newport Beach, CA.

Seminar on 2/28/94 at Texas Instruments, Dallas, TX.

Seminar on 3/8/94 at Xerox Impact, Palo Alto, CA.

Invited speaker and demo of MediaStation 5000 on 3/9/94 at Texas Instruments News Conference, San Francisco, CA.

Held a Press Conference on 3/10/94 with presentation and demonstration of MediaStation 5000 at the University of Washington, Seattle, WA.

Invited speaker and demo of MediaStation 5000 on 3/16-3/23/94 at CeBit Conf., Hannover, Germany.

Demonstrated MediaStation 5000 on 3/16-3/17/94 at UW Computer Fair.

Seminar on 3/24/94 at Siemens Medical Systems, Erlangen, Germany.

Seminar on 3/29/94 at Microsoft, Redmond, WA.

Presentation and demo of MediaStation 5000 on 4/1/94 at Data Compression Conf., Snowbird, UT.

Seminar on 4/14/94 at Madigan Army Medical Center, Tacoma, WA.

Seminar on 4/18/94 at Electrical Engineering EE500B, UW.

Demonstrated MediaStation 5000 on 4/22-4/23/94 at Engineering Open House, UW.

Keynote speaker on 4/28/94 at the UW EE Industrial Affiliates Meeting, Seattle, WA.

Seminar on 5/17/94 at Panasonic, Yokohama, Japan.

Seminar on 5/17/94 at Sony, Tokyo, Japan.

Seminar on 5/18/94 at Kirin Techno-System, Yokohama, Japan.

Seminar on 6/07/94 at Veterans Administration, American Lake, WA.

Invited speaker on 6/07/94 at the Puget Sound Federal Health Council, Tacoma, WA.

Seminar on 7/05/94 at Veterans Administration Medical Center, Seattle, WA

Seminar on 7/06/94 at Madigan Army Medical Center, Tacoma, WA.

Invited speaker on 7/08/94 at the Argonne National Laboratory's Workshop, Argonne, IL.

Seminar on 7/10/94 at University of Wisconsin, Madison, WI.

Invited speaker on 7/15/94 at the UW Board of Regents meeting, Seattle, WA.

Seminar on 9/26/94 at Electrical Engineering EE500B, UW.

Presentation on 9/30/94 at General Electric Users Meeting, Seattle, WA.

Demonstrated MediaStation 5000 at DSP World, Electronic Imaging, Comdex, and RSNA in Oct. & Nov. 1994.

Invited speaker on 11/1/94 at SPIE Critical Review on "Defining the Global Information Infrastructure," Boston, MA.

Seminar on 12/5/94 at Electrical Engineering EE500B, UW.

Telemedicine presentation and demo on 01/13/95 at Madigan Army Medical Center, Tacoma, WA.

Seminar on 1/19/95 at Sony Electronics, Inc., San Diego, CA.

Seminar on 1/25/95 at Xerox Impact, Inc., Palo Alto, CA.

Seminar on 1/25/95 at Compression Labs Inc., San Jose, CA.

Seminar on 2/8/95 at Picker International, St. Davids, PA.

Seminar on 2/13/95 at Electrical Engineering EE500B, UW.

Seminar on 4/3/95 at Electrical Engineering EE500B, UW.

Seminar on 4/18/95 at the UW HKN meeting, UW.

Seminar on 4/19/95 at Siemens Medical Systems, Issaquah, WA.

Seminar on 4/24/95 at Electrical Engineering EE500B, UW.

Presentation on 4/27/95 at the UW EE Corporate Day, UW.

Invited speaker on 5/25/95 at the IEEE Computer Society and EMBS Seattle Chapter Meeting, Bellevue, WA.

Seminar on 6/5/95 at Hitachi Systems Development Laboratory, Yokohama, Japan.

Seminar on 6/6/95 at Hitachi Semiconductor Division, Tokyo, Japan.

Seminar on 7/3/95 at Hitachi Systems Development Laboratory, Yokohama, Japan.

Invited Speaker on 7/5/95 at the KISS-KOCSEA Workshop on Information Superhighway, Seoul, Korea.

Seminar on 7/6/95 at the LG Production Engineering Research Center, Pyungtaek, Korea.

Seminar on 7/8/95 at the Pohang University of Science and Technology, Pohang, Korea.

Visiting Professor from 7/10-7/11/95 at the Korea Advanced Institute of Science and Technology, Seoul, Korea.

Seminar on 7/10/95 at the Korea Advanced Institute of Science and Technology, Seoul, Korea.

Seminar on 7/11/95 at the Korea University, Seoul, Korea.

Invited speaker on 8/20/95 at the Fourth International Conference on Image Management and Communication (IMAC 95), Honolulu, HI.

Invited speaker on 9/2/95 at the KSEA International Technical Conference, San Francisco, CA.

Seminar on 10/2/95 at Electrical Engineering EE500B, UW.

Presentation on 10/26/95 at the UWEE Corporate & Professional Advisory Board meeting, UW.

Seminar on 11/16/95 at the George Washington University, Washington, DC.

Seminar on 11/29/95 at the University of Illinois, Urbana, IL.

Seminar on 1/12/96 at Sharp Laboratories of America, Camas, WA.

Seminar on 1/12/96 at Tektronix, Beaverton, OR.

Seminar on 2/6/96 at the Iowa State University, Ames, IA.

Seminar on 3/4/96 at Electrical Engineering EE500B, UW.

Seminar on 3/13/96 at HP Laboratories, Palo Alto, CA.

Presentation on 3/14/96 at DSPx Conference, San Jose, CA.

Presentation on 3/21/96 at Texas Instruments, Houston, TX.

Visiting Professor on medical imaging from 4/1l/96-4/12/96 at the Cleveland Clinic, Cleveland, OH.

Seminar on 4/11/96 at the Cleveland, Clinic, Cleveland, OH.

Seminar on 4/12/96 at the Cleveland Clinic, Cleveland, OH.

Seminar on 4/16/96 at the Purdue University, West Lafayette, IN.

Seminar on 4/22/96 at Electrical Engineering EE500B, UW.

Visiting Professor from 5/27-5/29/96 at the Korea Advanced Institute of Science and Technology, Taejon, Korea.

Seminar on 5/31/96 at the Korea Advanced Institute of Science and Technology, Seoul, Korea.

Seminar on 5/31/96 at the Korea Medical Insurance Corporation, Seoul, Korea.

Seminar on 6/7/96 at the Siemens Medical Systems Ultrasound Group, Issaquah, WA.

Seminar on 6/24/96 at the General Electric Medical Systems Europe, Paris, France.

Seminar on 9/4/96 at Analogic, Peabody, MA.

Seminar on 9/4/96 at Atlantic Aerospace Electronic Corp., Waltham, MA.

Seminar on 9/5/96 at Hewlett Packard, Andover, MA.

Seminar on 9/5/96 at Imaging Technology Inc., Bedford, MA.

Seminar on 9/6/96 at Mercury Computer Systems, Chelmsford, MA.

Seminar on 9/11/96 at Quadtek, Redmond, WA.

Seminar on 9/23/96 at Ewha Womans University, Seoul, Korea.

Seminar on 9/24/96 at Seoul National University, Seoul, Korea.

Presentation on 9/26/96 at Canon, Tokyo, Japan.

Seminar on 9/30/96 at Electrical Engineering EE500B, UW.

Seminar on 10/28/96 at Echotech, Munich, Germany.

Seminar on 10/28/96 at Siemens Medical Systems, Erlangen, Germany.

Seminar on 11/11/96 at Coreco, Montreal, Canada.

Held a joint Press Conference between the University of Washington and Siemens Medical Systems on 11/25/96 with presentation and demonstration of UWGSP8 at the University of Washington, Seattle, WA.

Seminar on 11/25/96 at Electrical Engineering EE500B, UW.

Demonstrated the UWGSP8 technology and commercial product at the Radiological Society of North America (RSNA) Conference from 12/1/96-12/6/96, Chicago, IL.

Invited Speaker on 12/4/96 at the IEEE EMBS Chicago Chapter Meeting, Chicago, IL.

Seminar on 12/5/96 at 3M, St. Paul, MN.

Seminar on 1/29/97 at ENSCO, Inc., Springfield, VA.

Demonstrated on 2/12/97 the UWGSP8 technology at the CEO breakfast meeting, UW.

Seminar on 2/12/97 at Bioengineering BIOENG 510, UW.

Demonstrated on 2/12/97 our technologies to the Washington State legislators, Olympia, WA.

Invited speaker on 3/6/97 at the Global Forum on Telemedicine, Vienna, VA.

Seminar on 3/25/97 at Hitachi Systems Development Laboratory, Kawasaki, Japan.

Seminar on 3/26/97 at Sony-Kihara Research Center, Tokyo, Japan.

Seminar on 3/27/97 at Samsung Electronics, Suwon, Korea.

Seminar on 3/28/97 at the Korea Advanced Institute of Science and Technology, Seoul, Korea.

Seminar on 5/13/97, IEEE & Eta Kappa Nu Lecture Series, UW.

Seminar on 5/19/97 at Electrical Engineering EE500B, UW.

Seminar on 5/26/97 at the University of Nijmegen, the Netherlands.

Seminar on 5/26/97 at the Department of Urology, University Hospital Nijmegen, the Netherlands.

Seminar on 5/28/97 at the University of Rennes, Rennes, France.

Seminar on 5/30/97 at the University of Nantes (IRESTE), Nantes, France.

Keynote speaker on 6/2/97 at the Canon Seattle Meeting, Seattle, WA.

Seminar on 6/26/97 at Washington State University, Pullman, WA.

Seminar on 6/27/97 at Key Technology, Walla Walla, WA.

Invited speaker on 7/26/97 in the UW Continuing Legal Education Course, "Pacific Rim High Technology Protection Practice Update," Seattle, WA.

Speaker on 8/15/97 at one of the focus groups during the Bioengineering Summer Symposium, Seattle, WA.

Invited speaker on 9/8/97 at the Information Technology Applications in Biomedicine Conference, Prague, Czech Republic.

Seminar on 9/25/97 at Tektronix, Beaverton, OR.

Seminar on 9/26/97 at Oregon State University, Corvallis, OR.

Speaker on 9/29/97 at one of the focus groups during the Inter-Regional Visit by St. Louis/Washington University, Seattle, WA.

Seminar on 9/29/97 at Electrical Engineering EE500B, UW.

Seminar on 10/7/97 at Samsung Electronics, Kiheung, Korea.

Seminar on 10/8/97 at LG Semicon, Seoul, Korea.

Invited speaker on 10/10/97 at the Fifth International Conference on Image Management and Communication (IMAC '97), Seoul, Korea.

Invited speaker on 10/28/97 at the 19th International IEEE/EMBS Conference, Chicago, IL.

Seminar on 10/31/97 at University of Michigan, Ann Arbor, MI.

Seminar on 11/6/97 at Bioengineering BIOENG 510, UW.

Seminar on 11/13/97 at Equator Technologies, Campbell, CA.

Seminar on 12/1/97 at University of Wisconsin, Madison, WI.

Presentation on 1/15/98 to the UW Board of Regents, UW.

Seminar on 2/9/98 at Electrical Engineering EE500B, UW.

Seminar on 2/11/98 at Bioengineering Faculty Lecture, UW.

Seminar on 2/16/98 at Sarnoff Corporation, Princeton, NJ.

Seminar on 2/20/98 at Sony Electronics, San Diego, CA.

Seminar on 3/17/98 at Matsushita Communications, Yokohama, Japan.

Seminar on 3/17/98 at Sony Corporation, Tokyo, Japan.

Seminar on 3/19/98 at ETRI (Electronics and Telecommunications Research Institute), Taejon, Korea.

Seminar on 3/19/98 at Adept Technology, San Jose, CA.

Seminar on 4/17/98 at Pennsylvania State University, State College, PA.

Seminar on 5/15/98 at Johns Hopkins University, Baltimore, MD.

Seminar on 6/1/98 at Electrical Engineering EE500B, UW.

Seminar on 6/12/98 at Mayo Clinic and Foundation, Rochester, MN.

Seminar on 6/16/98 at Canon Research France, Rennes, France.

Lecturer at the 1998 IEEE/EMBS Summer School, June 13-21, 1998, Berder Island, France.

Seminar on 6/22/98 at Canon Research Europe, Guildford, UK.

Seminar on 6/23/98 at Criterion Software, Guildford, UK.

Invited speaker at the Pacific Medical Technology Symposium-PACMEDTek, August 17-21, 1998, Honolulu, HI.

Keynote speaker at the UW Bioengineering Retreat, October 17, 1998, Friday Harbor, WA.

Seminar on 10/19/98 at Electrical Engineering EE500B, UW.

Seminar on 10/29/98 at Canon, Tokyo, Japan.

Seminar on 11/9/98 at Jeju National University, Jeju, Korea.

Seminar on 11/12/98 at Canon, Kawasaki, Japan.

Seminar on 11/16/98 at Myongji University, Yongin, Korea.

Seminar on 11/17/98 at Bioengineering BIOEN510, UW.

Demonstrated our technology, MAP1000, at the COMDEX '98, November 16–20, 1998, Las Vegas, Nevada.

Seminar on 12/7/98 at Electrical Engineering EE500B, UW.

Seminar on 1/4/99 at Electrical Engineering EE500B, UW.

Seminar on 1/15/99 at George Mason University, Fairfax, VA.

Seminar on 2/22/99 at Electrical Engineering EE500B, UW.

Grand round speaker on 3/15/99-3/16/99 at the University of Pennsylvania Medical Center, Philadelphia, PA.

Seminar on 4/21/99 at GAIO Technology Co. in Tokyo, Japan.

Seminar on 4/22/99 at Canon Central Research Center, Atsugi, Japan.

Seminar on 6/1/99 at Bioengineering BIOEN299, UW.

Seminar on 8/25/99 at Philips, Sunnyvale, CA.

Presentation on 8/30/99 at Canon Medical in Tokyo, Japan.

Keynote speaker on 9/1/99 in Tokyo, Japan, Mediaprocessor Forum organized by Hitachi.

Keynote speaker on 9/2/99 in Osaka, Japan, Mediaprocessor Forum organized by Hitachi.

Presentation on 9/6/99 at Matsushita Communications in Yokohama, Japan.

Seminar on 9/7/99 at Fujitsu Laboratories in Kawasaki, Japan.

Seminar on 9/27/99 at EE500B/BIOEN599K, UW.

Seminar on 10/5/99 at Bioengineering BIOEN510, UW.

Keynote presentation at the Bioengineering retreat on 10/9/99.

Seminar on 10/21/99 at ATL, Bothell WA.

Seminar on 11/4/99 at Bioengineering BIOEN510, UW.

Seminar on 1/6/00 at Bioengineering BIOEN599J, UW.

Seminar on 1/17/00 at Intel in Santa Clara, CA.

Seminar on 2/28/00 at the Department of Rehabilitation Medicine's Monthly Research Seminar Series, UW.

Keynote presentation on 4/24/00 at the MAP UWICL Consortium Meeting, Seattle, WA.

Seminar on 5/4/00 at Bioengineering BIOEN599J, UW.

Presentation on 5/16/00 at Hitachi Medical Corp., Kashiwa, Japan.

Keynote speaker on 5/17/00 in Tokyo, Japan, Mediaprocessor Forum organized by Hitachi.

Seminar on 5/18/00 at Hitachi Central Research Laboratory, Tokyo, Japan.

Seminar on 5/19/00 at Canon, Tokyo, Japan.

Invited speaker on medical imaging on 6/16/00 at Canon, Tokyo, Japan.

Keynote speaker at the Irish Signals and Systems Conference, 6/29-6/30/00, Dublin, Ireland.

Seminars on 7/10/00 and 7/11/00 at the University of Padova, Padova, Italy.

Seminar on 7/27/00 at LizardTech, Seattle, WA.

Lecture on 8/17/00 at the UW Executive MBA Program, UW.

Seminar on 8/21/00 at the Vanderbilt University, Nashville, TN.

Seminar on 8/30/00 at Sony, San Diego, CA.

Seminar on 8/31/00 at Texas Instruments, Houston, TX.

Seminar on 9/12/00 at Nanyang Technological University, Singapore.

Seminar on 9/14/00 at Sony, Tokyo, Japan.

Seminar on 9/25/00 at EE500B/BIOEN599K, UW.

Seminar on 9/26/00 at Bioengineering BIOEN510, UW.

Keynote presentation on 10/2/00 at the UW MPUC Consortium Meeting, Seattle, WA.

Presentation on 11/2/00 at the Washington Research Foundation Board meeting, Seattle, WA.

Seminar on 11/2/00 at Bioengineering BIOEN510, UW.

Keynote presentation on 11/20/00 at the MAP UWICL Consortium Meeting, Seattle, WA.

Seminar on 1/4/01 at Bioengineering BIOEN599J, UW.

Keynote presentation on 1/22/01 at the UW MPUC Consortium Meeting, Seattle, WA.

Seminar on 2/9/01 at Medtronic-Physio Control, Redmond, WA.

Seminar on 2/28/01 at VideoTele.com, Lake Oswego, OR.

Seminar on 2/28/01 at Tektronix, Beaverton, OR.

Presentation on 3/2/01 to the Washington State Congressional Delegation, Washington, DC.

Presentation on 3/14/01 to National Science and Technology Board, Singapore.

Seminar on 3/16/01 at Hitachi Medical Corp., Kashiwa, Japan.

Presentation on 4/6/01 at the UW Medical School Executive Committee, UW.

Keynote presentation on 5/14/01 at the MAP UWICL Consortium Meeting, Seattle, WA.

Keynote presentation on 5/14/01 at the UW MPUC Consortium Meeting, Seattle, WA.

Seminar on 5/24/01 at Bioengineering BIOEN599J, UW.

Presentation on 6/18/01 at Texas Instruments, Dallas, TX.

Keynote speaker on 6/27/01 at the 4th Embedded Systems Expo & Conference, Tokyo, Japan.

Presentation on 7/6/01 at National Science and Technology Board, Singapore.

Presentation on 7/16/01 at Hitachi Medical Corp., Kashiwa, Japan.

Seminar on 7/17/01 at Hitachi Systems Development Laboratory, Kawasaki, Japan.

Seminar on 7/19/01 at Samsung Electronics, Suwon, Korea.

Keynote speaker of a workshop on Bioengineering on 7/20/01 at KAIST, Taejon, Korea.

Presentation on 8/29/01 at TeraRecon, Inc., Concord, MA.

Seminar on 9/17/01 at Intel, Santa Clara, CA.

Seminar on 9/17/01 at Sony, San Jose, CA.

Seminar on 10/1/01 at BIOEN599K/EE500B, UW.

Seminar on 10/2/01 at BIOEN510, UW.

Seminar on 11/8/01 at BIOEN510, UW.

Seminar on 11/16/01 at EE592, UW.

Presentation on 12/13/01 at Matsushita, Tokyo, Japan.

Seminar on 1/10/02 at BIOEN599J, UW.

Invited speaker on 1/17/02 at the University of Texas, Austin.

Presentation on 2/13/02 at Micron Imaging, Pasadena, CA.

Presentation on 3/29/02 at Fujisawa Pharmaceutical, Tokyo, Japan.

Keynote presentation on 4/22/02 at the C64 Consortium Meeting, Seattle, WA.

Presentation on 5/16/02 at Fujisawa Pharmaceutical, Tsukuba, Japan.

Keynote presentation on 5/20/02 at the MAP UWICL Consortium Meeting, Seattle, WA.

Seminar on 5/22/02 at Bioengineering BIOEN480B, UW.

Invited speaker on 8/8/02 at the Texas Instruments Developer Conference, Houston, TX.

Presentation on 9/12/02 at Canon, Tokyo, Japan.

Presentation on 9/13/02 at Sony, Tokyo, Japan.

Invited speaker on 9/19/02 at the Georgetown University, Washington, DC.

Keynote presentation on 9/23/02 at the C64 UWICL Consortium Meeting, Seattle, WA.

Seminar on 9/30/02 at BIOEN599K/EE500B, UW.

Presentation on 10/2/02 at the Surgery Forum, UW.

Seminar on 10/14/02 at BIOEN599K/EE500B, UW.

Seminar on 10/29/02 at BIOEN299, UW.

Seminar on 11/14/02 at BIOEN510, UW.

Keynote speaker on 11/21/02 at the Embedded Technology 2002, Yokohama, Japan.

Seminar on 11/25/02 at Jeju National University, Jeju, Korea.

Seminar on 11/27/02 at Seoul National University, Seoul, Korea.

Invited speaker on 12/18/02 at the Conference on Gels, Genes, Grafts, and Giants: Transitioning into the 21st Century, Maui, HI.

Seminar on 1/9/03 at BIOEN599J, UW.

Invited speaker on 1/18/03 at the Forum on Innovation and Entrepreneurship in Biomedical Engineering Education, San Francisco, CA.

Demonstrated our JPEG 2000 encoder and decoder at NAB Exhibition, 4/7/03 – 4/10/03, Las Vegas, NV.

Seminar on 5/16/03 at School of Nursing, UW.

Seminar on 6/2/03 at Samsung Advanced Institute of Technology, Suwon, Korea.

Seminar on 6/4/03 at Seoul National University, Seoul, Korea.

Seminar on 6/5/03 at Pohang University of Science and Technology (POSTECH), Pohang, Korea.

Seminar on 8/19/03 at Singapore General Hospital, Singapore.

Keynote speaker on 8/22/03 at the Second International Symposium on BioSystems, Taejon, Korea.

Seminar on 8/25/03 at Samsung Electronics, Kiheung, Korea.

Seminar on 9/8/03 at the IBM Research Center, Yorktown Heights, NY.

Seminar on 9/29/03, 10/6/03, 10/13/03, 10/20/03, and 11/3/03 at BIOEN599K/EE500B, UW.

Seminar on 11/4/03 at BIOEN510, UW.

Lecturer at the 2003 College of Engineering Lecture Series, UW.

Seminar on 11/10/03 at Shanghai Jiao Tong University, Shanghai, China.

Seminar on 11/18/03 at BIOEN299, UW.

Keynote speaker on 11/12/03 at the Hitachi's ET2003 Private Conference, Yokohama, Japan.

Invited speaker on 11/29/03 at the NTU TIP Graduation Ceremony, Singapore.

Invited speaker on 12/15/03 at the National Science Council, Taipei, Taiwan.

Keynote speaker on 12/17/03 at the NSC-US Bioengineering Conference, Taipei, Taiwan.

Seminar on 1/8/04 at BIOEN599J, UW.

Seminar on 1/16/04 at Columbia University, New York, NY.

Presentation on 3/19/04 at the Everett Housing Authority, Everett, WA.

Speaker on 5/6/04 at the UW Dinner Series, Mercer Island, WA.

Lecture on 5/6/04 at BIOEN480, UW.

Presentation on 6/3/04 at Seoul Science High School, Seoul, Korea.

Lecturer in the International Summer School on Medical Devices and Biosensors, 6/26-6/30/04, Hong Kong.

Plenary speaker on 7/1/04 at the Symposium on Medical Devices and Biosensors, Hong Kong.

Keynote speaker on 7/21/04 at the Emerging Technologies Symposium, Seattle, WA.

Invited speaker on 8/19/04 at KAIST, Taejon, Korea.

Keynote speaker on 8/20/04 at the Third International Symposium on BioSystems, Taejon, Korea.

Distinguished speaker on 9/2/04 at the IEEE/EMBS Annual Conference, San Francisco, CA.

Keynote speaker at the International Bioengineering Conference 2004, 9/8-9/10/04, Singapore.

Invited speaker on 10/7/04 at the University of Illinois in Urbana Champaign.

Invited speaker on 10/9/04 at the University of Minnesota in Minneapolis.

Seminar on 10/12/04 at BIOEN299, UW.

Seminar on 10/18/04 at BIOEN599K, UW.

Seminar on 10/25/04 at BIOEN599K, UW.

Distinguished Lecturer on 11/4/04 at the University of California, Irvine.

Seminar on 11/9/04 at BIOEN510, UW.

Invited speaker on 11/10/04 at the Rochester Institute of Technology in Rochester, NY.

Keynote speaker on 12/28/04 at the 2nd Cairo International Biomedical Engineering Conference, Cairo, Egypt.

Many more presentations and demonstrations at the EE Department industrial reviews, Bioengineering, Radiology, Pathology Departments, professional conferences, workshops, tutorials, and formal and informal seminars at various companies, e.g., Boeing Aerospace Corp., IBM, Intel, Texas Instruments in Dallas and Houston, HP, Tektronix, Xerox, Micron, BBN, BBN Delta Graphics, MITRE, General Electric Medical Systems, Siemens Medical Systems, Siemens-Quantum, Picker, Sony, Hitachi, Toshiba, Canon, Sharp, Oki, Medtronic, Physio Control, CPI, Spectragraphics, Acucela, Equator Technologies, Seattle Silicon, Appian, Optimedx, Neopath, PDI, Asymetrix, Optimas, VLSI Technology, LSI Logic, Compression Labs, Brooktree, Ariel, Ithaca Software, Virtual Imaging, Indec, Aptec, ETRI, GoldStar, Samsung Electronics, Samsung Data Systems, Samsung Medical Center, Daewoo Telecom, Hyundai, Leading Edge Products, Zymos, Lotte-Canon, and others.

Continuing Education

Organized and taught the UW Engineering Continuing Education 24-Hour Short Course, "Image Processing," during 12/19/84 - 12/21/84 to 24 engineers.

Organized and taught the UW Engineering Continuing Education 30-Hour Short Course, "16 and 32-bit Microcomputer System Design," during 2/5/85 - 3/7/85 to 22 engineers.

Organized and taught the UW Engineering Continuing Education 42-Hour Short Course, "Digital Electronics and Computer Design," during 3/19/85 - 4/25/85 to 20 engineers.

Taught the UW Engineering Continuing Education 24-Hour Short Course, "Digital Image Processing," during 9/23/85 - 9/25/85 to 32 engineers.

Taught the UW Engineering Continuing Education 42-Hour Short Course, "Digital Electronics and Computer Design," during 1/21/86 - 2/27/86 to 15 engineers.

Taught the UW Engineering Continuing Education 30-Hour Short Course, "16 and 32-bit Microcomputer System Design," during 3/11/86 - 4/10/86 to 16 engineers.

Taught the UW Engineering Continuing Education 24-Hour Short Course, "Digital Image Processing," during 5/19/86 - 5/21/86 to 25 engineers.

Member of the organizing committee and taught a portion of "Modern Technical Concepts," to 15 technical managers during 9/21/86 - 9/26/86.

Taught the UW Engineering Continuing Education course, "Advanced Microcomputer System Design," during 4/14/87 - 5/14/87 to 31 engineers.

Taught the UW Engineering Continuing Education course, "Digital Image Processing and Computer Systems," during 9/23/87 - 9/25/87 to 20 engineers.

Organized and taught the UW Engineering Continuing Education Short Course, "Image Computing Systems and Applications: From Multimedia to Medicine," during 12/11/91 - 12/13/91 to 22 engineers.

Developed and taught the UW Engineering Continuing Education course, "Multimedia Algorithm, Chips and Systems" during 9/23/92 - 9/25/92 to 22 engineers.

Taught the Continuing Education course, "Multimedia, Algorithms, Chips and Systems" during 9/30/92 - 10/2/92 at Intel in Chandler, AZ, to 40 engineers.

Taught the UW Engineering Continuing Education course, "Multimedia Algorithms, Chips and Systems" during 12/9/92 - 12/11/92, San Jose, CA, to 15 engineers.

Taught the UW Engineering Continuing Education course, "Multimedia Algorithms, Chips and Systems" during 6/16/93- 6/18/93, to 14 engineers.

Taught the Continuing Education course, "Multimedia Algorithms, Chips, and Systems," during 11/22/93 - 11/25/93, Nantes, France, to 80 engineers.

Developed and taught a 1-week short course, "Media Processing, Processors, and Their Programming," during 5/25/98 - 5/29/98 in Seattle, WA.

Developed and taught (about 45%) a 4-week training course, "Mediaprocessors and Multimedia Processing" during 7/6/98 - 7/31/98 in Seattle, WA.

Developed and taught a 1-day short course, "Performance-Driven Programming on MAP1000" on 10/19/98 in Seattle, WA.

Developed and taught a 3-day short course, "Performance-Driven Programming on MAP1000" during 11/11/98 – 11/13/98 in Kawasaki, Japan.

Taught a 3-day short course, "Performance-Driven Programming on MAP1000" during 4/21/99 – 4/23/99 in Kawasaki, Japan.

Taught a 3-day short course, "Performance-Driven Programming on MAP1000" during 7/12/99 – 7/14/99 in Seattle, WA.

Taught a 3-day short course, "Performance-Driven Programming on MAP" during 5/17/00 - 5/19/00 in Tokyo, Japan.

Taught a 3-day short course, "Performance-Driven Programming on MAP" during 9/5/00 – 9/7/00 in Rochester, NY.

Developed a 5-week program with Nanyang Technological University, "Technopreneurship & Innovation Program" during 8/27/03 – 10/3/03 in Seattle, to 47 students from Singapore.

Offered a 5-week program with Nanyang Technological University, "Technopreneurship & Innovation Program" during 8/25/04 – 10/1/04 in Seattle, to 38 students from Singapore.

Others

Proposed and received equipment & software donation worth more than $3,000,000 from IBM, Texas Instruments, Hewlett Packard, Intel, Tektronix, VLSI Technology, Valid, Seattle Silicon, Cadence, Logic Automation, BIT, Fluke, Philips Medical, SUN Microsystems, Motorola, National Semiconductor, Samsung, NCR, Fairchild, Data I/O, TRW, Altera, Xilinx, Sony and other companies.

Invited and participated in the IBM Magnetic Storage Faculty Conference at IBM San Jose Research Laboratory, Feb. 20-21, 1985, HP Logic Symposium IX at Colorado Springs, June 12-14, 1985, IBM AEP Conference at San Diego, April 5-8, 1986, IBM AEP Conference at Boston, June 27- 30, 1987, and IBM AEP Conference at Berkeley, Nov. 13-15, 1987.

Member of the NIH Diagnostic Imaging Ad Hoc Study Section, 1993-1995.

Member of the research grant review team for the Whitaker Foundation in January 1995.

Member of the other NIH special study sections and the site visit team for research grant proposal reviews since Dec. 1984, and reviewed other NSF, NIH, National Sciences and Engineering Research Council of Canada (NSERC), and Hong Kong Research Grants Council proposals since 1984.

Member of the National Science Foundation (NSF) Faculty Awards for Women (FAW) Panel, and other NSF proposal review panels.

Member of the Medical Information and Image Management Consultation Committee for the Clinical Center of the National Institutes of Health (NIH), Oct. 24-25, 1988.

External expert reviewer of Ph.D. dissertations at other institutions.

Faculty Advisor for University of Washington Chapter of Tau Beta Pi, 1983 - 1985.

Coordinator of the campus-wide weekly seminar series on "Digital Image Processing Principles, Computer Systems and Applications," since 1984, and have invited more than 300 external and internal speakers on image computing, multimedia and medical imaging.

Selected in July 1990 as one of the outstanding young Koreans by *Chosun-Ilbo*, Seoul, Korea.

Selected in July 1990 by the *Seattle Weekly* as one of 39 people under 40 "who have made a difference and are likely to continue shaking things up in the 1990's".

Some of my research projects have been covered and discussed in detail at different times by various TV (CNN, national, local and foreign) & radio (National Public Radio and others) stations, wire services, and other publications such as the *Seattle Times,* the *Seattle PI, Business Week*, *EE Times*, and *Byte Magazine*, since 1986.

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Sixth Edition

Standards Coordinating Committee 10, Terms and Definitions
Jane Radatz, Chair

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unwanted reflections of energy into the glide-slope sector. *See also:* navigation. (AE) [42], 686-1982s

MARshall System for Aerospace Simulation (MARSYAS) A simulation language used for simulating large physical systems, designed for use by people inexperienced in simulation or programming. Allows equations and FORTRAN subroutines to be written along with the statements describing a block diagram model. (C) 610.13-1993

MARSYAS *See:* MARshall System for Aerospace Simulation.

maser (1) (data transmission) (microwave amplification by stimulated emission of radiation) The general class of microwave amplifiers based on molecular interaction with electromagnetic radiation. The nonelectronic nature of the maser principle results in very low noise. (PE) 599-1985w

(2) (laser maser) A device for amplifying or generating radiation by induced transitions of electrons, atoms, molecules, or ions between two energy levels having a population inversion; microwave amplification by stimulated emission of radiation. (LEO) 586-1980w

mask (1) (A) (computers) A pattern of characters that is used to control the retention or elimination of portions of another pattern of characters. (B) (computers) A filter. (C) [20], [85]

(2) (software) A pattern of bits or characters designed to be logically combined with an unknown data item to retain or suppress portions of the data item; for example, the bit string "00000011" when logically ANDed with an eight-bit data item, gives a result that retains the last two bits of the data item and has zero in all the other bit positions. *See also:* interrupt mask. (C) 610.12-1990

mask document In word processing, a form displayed on a display screen with blank areas for the user to complete. (C) 610.2-1987

masking (1) (A) The process by which the threshold of audibility for one sound is raised by the presence of another (masking) sound. (B) The amount by which the threshold of audibility of a sound is raised by the presence of another (masking) sound. The unit customarily used is the decibel. (Std100)

(2) (color television) A process to alter color rendition in which the appropriate color signals are used to modify each other. *Note:* The modification is usually accomplished by suitable cross coupling between primary color-signal channels. *See also:* television. (BT/SP) [32], [34]

masking audiogram A graphic presentation of the masking due to a stated noise. *Note:* This is plotted in decibels as a function of the frequency of the masked tone. (SP) [32]

masking, fault The result of applying error compensation systematically, even in the absence of error. (BA/C) 896.9-1994

mask&swap A data-access operation that stores a *next* value to the *test* specified bits within a specified data type and returns the previous data value. (C/MM) 1596.5-1993

maskSwap A bus transaction that stores bits of a *next* argument to a specified data address and returns the previous data value from that address. The affected bits are specified by a *test* argument. In the CSR Architecture this is called a mask_swap transaction. (C/MM) 1596.5-1993

masquerade The pretense by an entity to be a different entity. (C/LM) 802.10-1992

mass (International System of Units (SI)) The SI unit of mass is the kilogram. This unit, or one of the multiples formed by attaching an SI prefix to gram, is preferred for all applications. Among the base and derived units of SI, the unit of mass is the only one whose name, for historical reasons, contains a prefix. Names of decimal multiples and submultiples of the unit of mass are formed by attaching prefixes to the word gram. The megagram (Mg) is the appropriate unit for measuring large masses such as have been expressed in tons. However, the name ton has been given to several large mass units that are widely used in commerce and technology: the long ton of 2240 lb, the short ton of 2000 lb, and metric ton of 1000 kilograms (also called the tonne). None of these terms are SI. The term metric ton should be restricted to commercial usage, and no prefixes should be used with it. Use of the term tonne is deprecated. *See also:* units and letter symbols. (QUL) 268-1982s

Massachusetts General Hospital Utility Multi-Programming System (MUMPS) An ANSI standard programming system containing its own operating system, command language, and interactive programming language; designed specifically for medical applications and is particularly adaptable to string handling functions and management of hierarchical data. (C) 610.13-1993

mass-attraction vertical The normal to any surface of constant geopotential; it is the direction that would be indicated by a plumb bob if the earth were not rotating. *See also:* navigation. (AE) [42], 686-1982s

mass burning rate Mass loss per unit time by materials burning under specified conditions. (DEI) 1221-1993

mass loading The change in phase velocity of a surface acoustic wave produced by a thin layer on the substrate of higher density than that of the substrate; perturbations in reflections, velocity, and dispersion that occur due to loading effects of thin films on the substrate surface. (UFFC) 1037-1992

mass spectrograph An electronic device based on the action of a constant magnetic field on the paths of ions, used to separate ions of different masses. *See also:* electron device. (Std100) [84]

mass storage An area of storage, or a storage device, having a very large storage capacity. *Note:* Sometimes referred to as secondary storage in order to differentiate from main storage. *Synonym:* bulk storage. (C) 610.10-1994

mass unbalance (gyros) The characteristic of a gyro resulting from lack of coincidence of the center of supporting forces and the center of mass. It gives rise to torques caused by linear accelerations that lead to acceleration-sensitive drift rates. (AE) 528-1994

mast (power transmission and distribution) A column or narrow-base structure of wood, steel, or other material, supporting overhead conductors, usually by means of arms or brackets, span wires, or bridges. *Note:* Broad-base lattice steel supports are often known as towers; narrow-base steel supports are often known as masts. *See also:* pole; tower. (PE/T&D) [10]

mast arm *See:* bracket.

Master *See:* SBus Master.

master (1) (FASTBUS acquisition and control) A device that is capable of asserting or controlling an operation on a segment according to the FASTBUS protocol. A master may, in addition, contain slave logic. 960-1993

(2) (STD bus) A card controlling a bus transaction. The master that is currently controlling the bus is the current master. The card that is host to all other masters is the permanent master. All masters that are *not* the permanent master are temporary masters. (C/MM) 961-1987r

(3) (VMEbus) A functional module that initiates data transfer bus (DTB) cycles to transfer data between itself and a slave module. (BA/C) 1014-1987

(4) (VSB) A functional module that initiates bus cycles in order to transfer data between itself and VSB slaves. The master that is currently in control of the DTB is referred to as the *active* master. (C/MM) 1096-1988

(5) (NuBus) A bus device that initiates a transaction. (C/MM) 1196-1987

(6) (NuBus) A module that has acquired control of the bus through the control acquisition procedure. (BA/C) 1014.1-1994, 10857-1994, 896.3-1993, 896.4-1993

master antenna television system (MATV) A small television antenna distribution system usually restricted to one or two buildings. (C/LM) 802.7-1989

Universal Serial Bus Specification

Compaq

Intel

Microsoft

NEC

Revision 1.1
September 23, 1998

Chapter 6
Mechanical

This chapter provides the mechanical and electrical specifications for the cables, connectors, and cable assemblies used to interconnect USB devices. The specification includes the dimensions, materials, electrical, and reliability requirements. This chapter documents minimum requirements for the external USB interconnect. Substitute material may be used as long as it meets these minimums.

6.1 Architectural Overview

The USB physical topology consists of connecting the downstream hub port to the upstream port of another hub or to a device. The USB can operate at two speeds. Full-speed, 12 Mb/s, requires the use of a shielded cable with two power conductors and twisted pair signal conductors. Low-speed, 1.5 Mb/s, relaxes the cable requirement. Low-speed cable does not require shielding or twisted pair signal conductors.

The connectors are designed to be hot plugged. The USB Icon on the plugs provides tactile feedback making it easy to obtain proper orientation.

6.2 Keyed Connector Protocol

To minimize end user termination problems, USB uses a "keyed connector" protocol. The physical difference in the Series "A" and "B" connectors insure proper end user connectivity. The "A" connector is the principle means of connecting USB devices. All USB devices must have an "A" connector. The "B" connector allows device vendors to provide a standard detachable cable. This facilitates end user cable replacement. Figure 6-1 illustrates the keyed connector protocol.

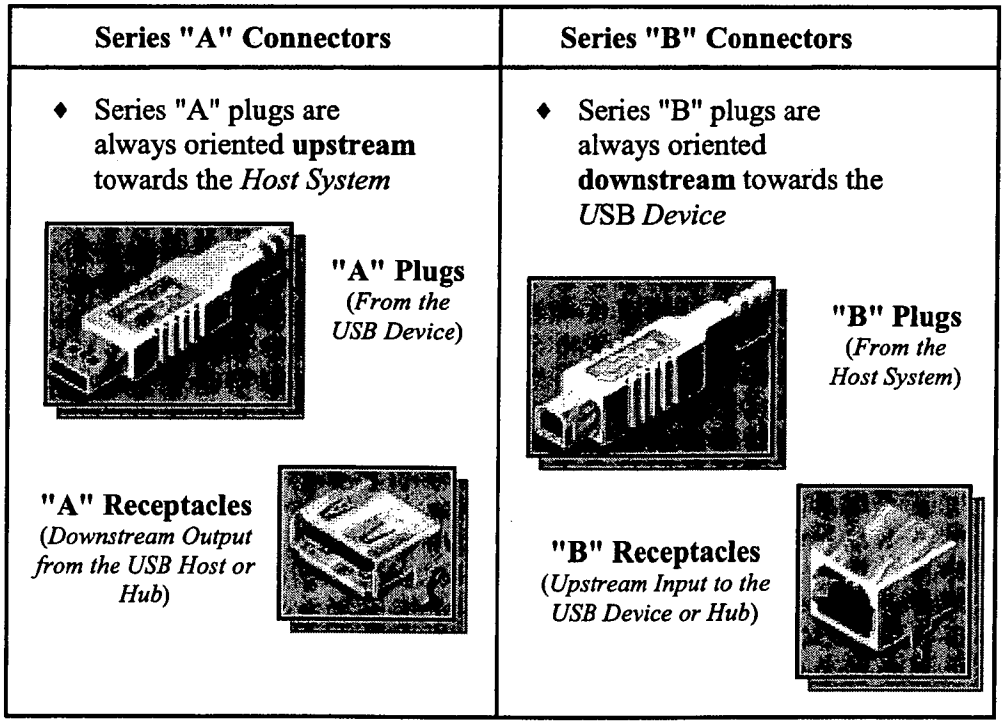

Figure 6-1. Keyed Connector Protocol

The following list explains how the plugs and receptacles can be mated:

- Series "A" receptacle mates with a Series "A" plug. Electrically, Series "A" receptacles function as outputs from host systems and/or hubs.
- Series "A" plug mates with a Series "A" receptacle. The Series "A" plug always is oriented towards the host system.
- Series "B" receptacle mates with a Series "B" plug (male). Electrically, Series "B" receptacles function as inputs to hubs or devices.
- Series "B" plug mates with a Series "B" receptacle. The Series "B" plug is always oriented towards the USB hub or device.

6.3 Cable

USB cable consists of four conductors, two power conductors and two signal conductors.

Full-speed cable consists of a signaling twisted pair, VBUS, GND, and an overall shield. Full-speed cable must be marked to indicate suitability for USB usage (see Section 6.6.2). Full-speed cable may be used with either Low-speed or Full-speed devices. When Full-speed cable is used with Low-speed devices, the cable must meet all Low-speed requirements.

Low-speed cable does not require twisted signaling conductors or the overall shield.

6.4 Cable Assembly

This specification describes three USB cable assemblies. Detachable cable, Full-speed captive cable, and Low-speed captive cable.

The color used for the cable assembly is vendor specific, recommended colors are White, Grey, or Black.

6.4.1 Detachable Cable Assemblies

Full-speed devices can utilize the "B" connector. This allows the device to have a detachable USB cable. This eliminates the need to build the device with a hardwired cable and minimizes end user problems if cable replacement is necessary.

Devices utilizing the "B" connector must be designed to work with worst case maximum length detachable cable. Detachable cable assemblies may be used only on Full-speed devices. Using a Full-speed detachable cable on a Low-speed device may exceed the maximum Low-speed cable length.

Figure 6-2 illustrates a detachable cable assembly.